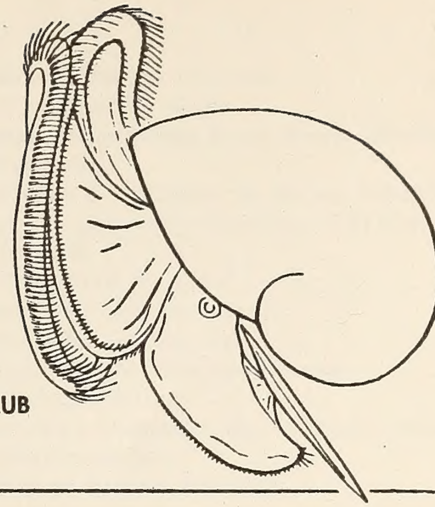
THE VELIGER



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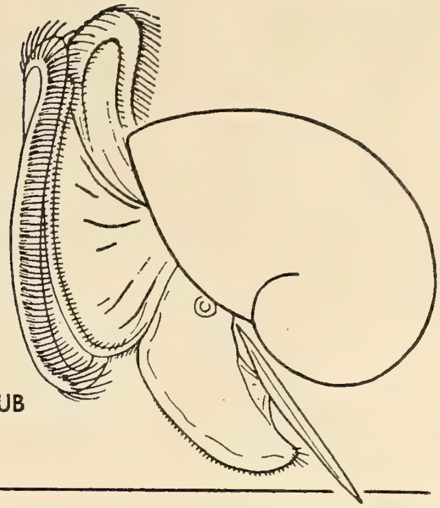
ERRATA

page 13, column 1, line 4 from bottom:
for 'the left margin' read: 'the right margin'
cover for No. 3:
for 'Opisthobranhia' read: 'Opisthobranchia'
page 111, column 1, line 3 from bottom:
for 'pp. 4-6' read: 'part 4-6''

THE VELIGER



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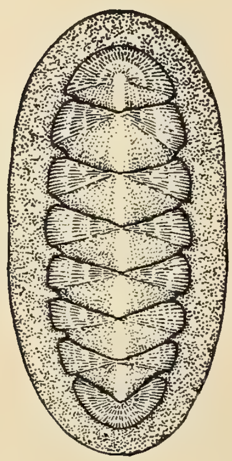

Note: The various taxa above species are indicated by the use of different type styles as shown by the following examples:

ORDER, Suborder, **DIVISION, Subdivision,** SECTION,
SUPERFAMILY, FAMILY, Subfamily, *Genus*, (*Subgenus*).

Observations on the Gastropod *Terebellum terebellum* (LINNAEUS), with Particular Reference to the Behavior of the Eyes during Burrowing

BY

DONALD P. ABBOTT

Hopkins Marine Station of Stanford University, Pacific Grove, California

Members of the prosobranch family Strombidae, particularly the species of Strombus, have long been known for their agility, their curious methods of locomotion, and their well-developed and often beautifully colored eyes. Traditionally these features have been regarded as possessions related to a predatory existence. However, the studies of Yonge (1932) and Robertson (1961) indicate that Lambis and Strombus are in reality specialized herbivores, feeding on small algae, algal detritus, and plant-like microorganisms, and that the same is very likely the case with the remaining genera of the family: Tibia, Dientomochilus, and Terebellum.

Terebellum terebellum (Linnaeus) is widely distributed in the Indo-Pacific region. The gross anatomy has been described by Bergh (1895), and some additions made by Robertson (1961). Further, it has been noted that the smooth, streamlined, and fusiform shell is clearly adapted to a burrowing life (Morton, 1958, p. 45). Nevertheless, little is known of the biology of the species. The only published observations I have found on the behavior of the living animal are those of Arthur Adams in his Narrative of the Voyage of the SAMARANG, quoted in Tryon (1885, vol. 7, p. 130):

"In its habits the animal of the Terebellum is exceedingly shy and timid, retracting its body into the shell on the slightest alarm. It will remain stationary for a long time, moving its tentacles about cautiously in every direction, when, suddenly, it will roll over with its shell, and continue again perfectly quiet. They appear to have all the muscular energy, vivacity, and doubtless, predatory boldness possessed by the Strombi, which they also resemble in their perfectly organized eyes, and quickness of vision. Mr. Cuming informs me that he has seen them leap several inches from the ground, exactly as I have seen the animal of Strombus gibberulus. On one occasion, a beautiful specimen was lost to the above-mentioned enthusiastic collector, by the animal suddenly leaping into the water, as he was holding and admiring it in the palm of his hand. Those I kept in confinement died in a few days, and appear to be of a more delicate constitution than the hardy Strombus."

During the Hawaii-Philippines-Sulu Sea Expedition, conducted in 1957 by the Bernice P. Bishop Museum (Honolulu) and the Philippines National Museum (Manila) with the generous support of Mrs. Mary Eleanor King of Honolulu, a brief opportunity arose to make some observations on living individuals of Terebellum terebellum. Several specimens were obtained at night near South Lagoon on Tumindao Reef south of the Sibutu Islands, at about latitude 4° 33' 30" N., longitude 119° 21' 30" E. The particular habitat was a great sandy flat, its surface nearly exposed at low tide and relatively barren except for isolated patches of turtle grass (Thalassia) and occasional deeper pools containing blocks of dead coral overgrown with algae. Some individuals of Terebellum were found partly exposed on the bottom; others were buried just below the surface, their positions indicated by shallow mounds. Identification of the specimens was made by Mr. Fernando Dayrit, conchologist from the Philippines National Museum, who accompanied the expedition. The following observations are casual rather than systematic and are presented in the hope that they will stimulate more complete observations by others.

The morning after collection the specimens were placed in a large bowl of seawater provided with an inch-deep layer of sand. Upon extending the foot from the shell, the animals flipped themselves over with such rapidity (taking less than a second) that the movement was difficult to follow. The long eyestalks, lacking tentacles and bearing globular, turquoise-blue eyes at the tips, were then extended anteriorly, and the animals commenced to burrow.

As each animal ploughed down into the sand, one of its eyestalks was extended upward and back over the shell. As this raised eyestalk was contacted by the sand which came to cover the anterior dorsal region of the shell, the or-

gan was moved in such a way that the terminal blue eyeball was placed just above the sand surface. The animals continued to move forward and down, burying themselves, but each one "left behind itself" one eye protruding above the surface. Since the exposed eye remained stationary relative to the sand around it, the eyestalk hidden below the sand was clearly elongating at a rate which matched the forward movement of the animal. When the shell was largely buried and its anterior end was judged to be approximately one inch ahead of the exposed eye, the siphon was extended upward through the sand at this point, the siphonal folds closely appressed to form a closed cone. Once at the surface, the siphonal folds flared open terminally, and a swift current of water was drawn down into the mantle cavity. Following this inhalation, the second eye, thus far concealed below the surface of the sand with the rest of the animal, passed upward through the lumen of the siphon. With the second eye now exposed, the siphon folds unrolled and the siphon was pulled down out of sight, leaving the blue eyeball just at the surface of the sand. Simultaneously, the first eye, an inch to the rear, was withdrawn below the surface and disappeared. These actions were observed to be repeated with only minor variations as the animals burrowed along, their shells covered by a layer of sand perhaps a centimeter in depth. Forward progression below the sand was nearly continuous, but the eyes were "walked" forward, with one of them always stationary and exposed at the surface like a periscope during the burrowing.

This remarkable behavior of the eyes, requiring highly extensile eyestalks and good coordination, deserves further study. However, it is not an entirely surprising development in Terebellum. It seems probable that the Strombidae are derived from a stock with the eyes arranged more or less as in Aporrhais (Yonge, 1937) and many other prosobranchs, where they bulge laterally from the bases of the tentacles. In species of Strombus the eyes are borne on greatly elongated eyestalks. The tentacles here arise from the eyestalks about half to three-quarters of the distance out from the bases toward the terminal eyes; they are comparatively small, and their tips scarcely reach beyond the distal ends of the eyes in preserved specimens (Bergh, 1895). In living Strombus the eyestalks extend forward and dorsally, and the eyes are held upward when the animal is active (Colton, 1905; Robertson, 1961). The right eyestalk curves upward through a special groove in the margin of the aperture, while the left curves upward in the groove of the very short siphon (Colton, 1905). This is of particular interest in view of the habit in Terebellum of passing the eye upward through the siphon during burrowing. In the latter form the siphon, while described by Bergh (1895) and others as short, is larger than in Strombus, a development probably related to the burrowing mode of life. The tentacles, in some Strombus species at least, are extended forward and downward in life, their tips just above the substrate or contacting it (Colton, 1905, pl. 3, figs. 11-13; Robertson, 1961). In Tibia the eyestalks and tentacles appear to be rather similar to those of Strombus (Pelseneer, 1906, fig. 46, after Adams). In Dientomochilus the tentacles are slightly longer than the eyestalks (Thiele, 1931). In Lambis the tentacles are very small and short in relation to the eyestalks, and arise near the tips of the latter (Pelseneer, 1906, fig. 75, after Woodward). The tendency in the Strombidae toward elongation of the eyestalks and reduction of the tentacles appears to reach its climax in the burrowing Terebellum, where the tentacles are entirely absent.

Adams & Adams (1858, as cited in Bergh, 1895, p. 370) and Bergh (1895) have noted specimens of Terebellum with asymmetrically developed eyes and eyestalks, and the figure in Tryon (1885, vol. 7, Strombidae, pl. 11, fig. 27, after Adams) suggests a slight asymmetry in eyestalk size. No such asymmetry was noted in expanded living individuals before burrowing commenced, though the eyestalks are certainly capable of elaborate independent and asymmetric activity.

The eyes themselves are exceptionally well-developed in members of the Strombidae. Their structure was studied a century ago in Strombus by Fischer, and numerous investigators and casual observers over the years have commented on the marked responses of strombids to visual stimuli (e. g., Tryon, 1880, p. 36; 1885, p. 106; Robertson, 1961). It seems not unlikely that this marked development of the eyes, the manner in which they are held, and their apparent sensitivity and acuity, are, like the ability of some strombids to jump and tumble rapidly, related primarily to protection and escape. The observations of Robertson (1961) show that the agility of Strombus functions importantly in escape responses evoked by the presence of predators. In this connection the slightly flattened shell and expanded outer lip of the aperture in numerous strombids may give the jumper a 50:50 chance of landing right side up, as well as lending stability in orientation

while lying on or moving across the bottom. In Lambis the specialized foot and operculum permit locomotion and righting on sand, while the heavy shell, broad outer lip, and marginal spines help prevent overturning of the unattached animal in turbulent water and sinking in while moving across soft sand (see Yonge, 1932).

In Terebellum no such stability in orientation is provided by the narrow, fusiform shell, and the very rapid and effective righting response seems related to the hazard of being frequently overturned. Leaping in Terebellum, as described in the quotation from Adams, was not noted in the present observations, though the animals taken wriggled the foot rapidly and to such effect that the first specimen taken in hand was immediately dropped. This ability, plus the periscopic "watchfulness" of the eyes during burrowing, suggest adaptations of value in protection and escape.

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The Search for *Turritella jewettii* Carpenter

BY

JAMES W. VALENTINE

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During the years 1864 to 1866, Philip P. Carpenter described two species of Turritella from southern California, T. cooperi and T. jewettii. So far as is known, neither species is represented by a designated type specimen, although material on which Carpenter may have based T. cooperi is in the collections of the Museum of Paleontology, University of California (Durham in Palmer, 1958, p. 168). There is little doubt but that the slim turritellid especially common in Plio-Pleistocene, Pleistocene, and Recent faunas of southern California is indeed T. cooperi, and this point is accepted without further question here.

During the preparation of her invaluable memoir on the types of Carpenter's west coast marine shells, Palmer (1958, pp. 169-170) made an extensive search for type material of Turritella jewettii. No specimens certainly identified by Carpenter as T. jewettii are known. All specimens that she found identified as T. jewettii and dating from Carpenter's time have proven to be T. cooperi, commonly young individuals. Cooper was evidently responsible for many of these sets. Merriam [1941, pp. 119 (footnote), 123] suggested that T. jewettii might have been based upon a fairly smooth variant of T. cooperi.

Turritella jewettii was based upon material included in ". . . a very interesting series of Pliocene fossils from the neighborhood of Santa Barbara" (Carpenter, 1864, p. 539). The locality is further described as being ". . . two miles from the coast, and 150 feet high" (Carpenter, loc. cit.). Carpenter's list of 45 forms in Jewett's collection leaves no doubt but that the fossils are from the Santa Barbara formation. Turritella jewettii was not well described until later (Carpenter, 1866b, p. 276). By that time Carpenter had specimens from San Diego that he identified as T. jewettii also. His remarks are "San Diego, on beach (Cassidy)", and "Mr. Cassidy's specimens may be washed fossils, or very poor recent shells" (Carpenter, loc. cit.).

Arnold (1903) identified as Turritella jewettii a species that is found in the Pleistocene at San Pedro but which is not certainly known to occur either in the Santa Barbara or San Diego regions. Arnold's T. jewettii did not agree very closely with Carpenter's description and so was redescribed as T. pedroensis by Applin (MS.; Merriam, 1941, pp. 121-123, pl. 35, figs. 1-9).

Until recently the only species of Turritella known to occur in the Santa Barbara formation aside from Carpenter's record of T. jewettii was T. cooperi, lending support to the hypothesis that T. jewettii was based on variants of T. cooperi. Turritella cooperi living and fossil occurs also at San Diego. However, recent collecting has resulted in the discovery of a second species of Turritella in the Santa Barbara formation (Valentine, 1962). This species is identified as T. hemphilli Merriam (Merriam, 1941, pp. 126-127, "Turritella vanvlecki subsp. hemphilli Applin MS"). The type of T. hemphilli is from the San Diego formation at Pacific Beach. Might the species called T. hemphilli be the lost T. jewettii of Carpenter?

In the Santa Barbara formation, Turritella hemphilli has been found at two localities in the Rincon Creek area (only half a mile from the ocean) and in an outcrop on Fairview Avenue (1.1 miles north of Goleta and 2.65 miles north of the ocean). All these localities are near 150 feet in elevation. Turritella hemphilli is associated with diverse molluscan assemblages that resemble the collection of Jewett as recorded by Carpenter. No specimens of T. hemphilli were found in the Packard's Hill region, although some localities there have yielded associations similar to Jewett's collection also.

Carpenter's original description of Turritella jewettii in Latin is readily available (1866b; reprinted, 1872; Oldroyd, 1927, p. 54 — note that the word "distantibus" in Carpenter's description is incorrectly given as "distinctibus" in Oldroyd). A translation has kindly been rendered by Professor Anna S. Benjamin, Department of Classical Languages, University of Missouri.

Shell turreted, quite terete and not at all thin; ashy yellow-red in color; whorls nearly flat, sutures distinct; surrounded by separate small ridges (of which two are rather prominent on the younger shell) and by subobsolete spiral furrows; base not very angulate; aperture subquadrate; lip thin, moderately sinuous [translation of Carpenter, 1866b, p. 276, lines 6-10].

This description closely fits Turritella hemphilli which has fine spirals with commonly two heavier spiral bands on early whorls which are themselves sculptured by fine spirals. On later whorls the heavy spirals decrease in strength and become obsolete while their fine spirals merge with those on the rest of the shell (well shown in Merriam, 1941, pl. 37, fig. 13; see also forms figured as T. vanvlecki teglandae, same plate).

It is interesting to contrast this description with that of Turritella cooperi (Carpenter, 1866a, also translated by Professor Benjamin). Turritella cooperi is described as rather thin, and T. jewettii as not at all thin; T. cooperi has two ridges, and T. jewettii has small ridges, two of which are especially pronounced on juvenile whorls; the base of T. cooperi is angulate, but of T. jewettii not very angulate; and T. cooperi has an exceedingly sinuous lip, while T. jewettii has only a moderately sinuous lip. It certainly appears that Carpenter had two fairly distinct forms at hand, and though it is conceivable that these differences could be between two variants of T. cooperi, they are also strikingly like the differences between T. cooperi and T. hemphilli.

Carpenter volunteered an additional bit of information about Turritella jewettii: it is ". . . nearest to T. sanguinea, Rve., from the Gulf, but differs in the faintness of the sculpture" (Carpenter, 1866b, p. 276). Turritella sanguinea is evidently a South African species incorrectly assigned to "California" by Reeve (1849, species 27, pl. 6, fig. 27). Carpenter's early references to it are based on Reeve's record (Carpenter, 1857). Later Carpenter lists it from La Paz (1864, p. 622), though it is not certain whether or not the identification was his own. If it was, he must have had some Gulf of California species in mind.

Four species are known to include La Paz in their present ranges: Turritella gonostoma, T. leucostoma, T. mariana, and T. nodulosa. Of these, T. mariana and T. nodulosa look so little like Carpenter's description of T. jewettii, which "T. sanguinea" is said to resemble, as to be immediately eliminated as candidates for a form that Carpenter identified as T. sanguinea. Both of the other species were known to Carpenter who lists them in early reports. The whorls of T. leucostoma are contracted anteriorly, and sculptural details do not agree well with Carpenter's description of T. jewettii. Turritella gonostoma is closely allied to T. hemphilli and may be conspecific with it.

A shell from South Africa identified as Turritella sanguinea and closely resembling Reeve's figure is at hand; it has rather fine spirals as Reeve's figure suggests, but stronger than those on adult T. hemphilli. It is dissimilar to both T. hemphilli and T. cooperi and resembles T. gonostoma only vaguely in color pattern. It does not seem that Carpenter's reference to T. sanguinea can be used at present as strong evidence in establishing the identity of T. jewettii, though it serves to emphasize that the sculpture of T. jewettii is weak.

In summary, the distribution of Turritella hemphilli and its close agreement with Carpenter's description of T. jewettii suggests that these two forms may be identical. If this suggestion is accepted, T. jewettii has priority and must replace T. hemphilli. A neotype in better condition than the specimens at hand would be desirable.

Acknowledgment

I am most grateful to Mrs. Lou Ella Saul, Department of Geology, University of California, Los Angeles, for the loan of the specimen of Turritella sanguinea, for copies of Reeve's description and illustration, and for other aid. Special thanks are due Professor Anna S. Benjamin, University of Missouri, for translating Carpenter's descriptions.

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Comparison of Two Rare Cowrie Species (Gastropoda)

BY

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(Plates 1, 2, 3, 4; 2 Textfigures)

The need for modern illustrations to resolve the confusion between Cypraea (Zoila) venusta Sowerby, 1846, and C. (Z.) episema Iredale, 1939, became apparent to me recently after studying several specimens that seemed identical, though according to their labels, representing both species. Upon comparing these specimens very closely with one in my collection labelled C. venusta (see Plates 1 and 2, Figs. 1a, 1b), and verifying the identities of both species through pertinent literature, I realized that no really adequate modern figure of either had been published. Iredale (1939, Pl. 27, Figs. 3, 4) provided photographs of dorsal and ventral views of C. episema (reproduced here on Plate 3, Figs. 1a, 1b), but these were unfortunately somewhat blurred in the original reproduction. Allan (1956, Pl. 13, Fig. 1) represented only C. venusta, with drawings that do not clearly indicate the detail it is possible to portray in a photographic illustration. Schilder (1960, Pl. 14, Fig. 1) figured C. episema with good photographs of dorsal and lateral views, but the ventral aspect, which is the most important for the purpose of distinguishing between C. episema and C. venusta, is lacking. Weaver (1961, p. 5) illustrated the specimen of C. venusta used in this study with three well-reproduced photographs. Aside from the above-mentioned modern figures, one must refer to Sowerby (1870, Pl. 2, Figs. 5, 6), Cox (1869, p. 358, Pl. 26, Figs. 1, 1a), Cox (1889, p. 187, Pl. 15, Figs. 1, 2), Weinkauff (1881, Pl. 20, Figs. 6, 7), and Tryon (1885, p. 176, Pl. 10, Figs. 44, 45) for the only other illustrations of either species that I have been able to locate in the literature. The purpose of this paper is to trace the references to C. venusta and C. episema, and to illustrate both species as fully as possible, with special emphasis on pointing out the differences between them.

I have been fortunate in being able to examine at first-hand eight specimens of Cypraea episema. This unusual opportunity has been made possible through the kindness of Mr. William E. Old of the American Museum of Natural History (Plate 2, Figs. 2a, 2b), Mr. E. L. Fobes of Omaha (Plate 2, Figs. 3a, 3b), and Mr. Clifton Weaver of Honolulu (Plate 3, Figs. 2a, 2b), all of whom have loaned their specimens for study. Mr. Ray Summers of Petaluma, California, also allowed me to study and measure the specimens in his collection, and Mrs. Thelma Hartley of Melbourne kindly provided color transparencies and the approximate measurements of specimens in her collection. The other shells observed are in my own collection, including the C. venusta which I purchased from Mr. Weaver; the measurements and locality data for all specimens used are included in Table I. I had hoped to secure photographs of the holotype of C. venusta for inclusion here, but due to the reorganizational work now being done at the British Museum (Natural History) it was not possible to do so.

Cypraea venusta and C. episema are closely related species of the subgenus Zoila Jousseaume, 1884, which is characterized chiefly by weakly developed apertural teeth and by frequently incomplete series of columellar teeth. Other species or subspecies assigned to this subgenus at the present time are C. friendii Gray, 1831 (type species), C. thersites Gaskoin, 1848, C. marginata Gaskoin, 1848, C. decipiens Smith, 1880, C. vercoi Schilder, 1930, C. contraria Iredale, 1935, and C. rosselli Cotton, 1948. All are of uncommon to rare occurrence, most are deep water species, and all are restricted to western and southern Australia.

The present taxonomic position of Cypraea venusta is as follows:

CYPRAEIDAE FLEMING, 1828 (em.)
Cypraeinae STOLICZKA, 1867
Cypraea LINNAEUS, 1758
Zoila JOUSSEAUME, 1884
venusta SOWERBY, 1846

Synonyms:
Cypraea thatcheri COX, 1869
Cypraea roseopunctata MELVILL, 1888 (*nom. nud.*)
Cypraea brunea COX, 1889
Cypraea venusta var. *brunea* [COX] HIDALGO, 1906
Cypraea venusta var. *bakeri* GATLIFF, 1916

Because of the unavailability to most collectors of the early volume of the Journal of the Linnean Society of London containing Sowerby's original description, I include here a copy of the original Latin description, and a literal translation into English which was generously furnished by Mr. George P. Kanakoff of the Los Angeles County Museum.

Cypraea venusta, testâ ovato-ventricosâ utrâque extremitate anticâ praecipuè subrostratâ, dorso gibboso carnicolore maculis pallidè castaneis notato, lateribus basalibus incrassatis carnicoloribus, extremitatibus pallidè castaneis roseo-tinctis, basi subplanulatâ albicante extremitatibus carnicoloribus, spirâ validâ obtusâ anfractibus duobus, aperturâ elongatâ angustâ rectiusculâ intùs roseâ posticè in canalem brevem sinistralem exeunte anticè subflexuosâ, canali anticâ brevi rectiusculâ paululùm deflexâ, dentibus labii externi circa 25 magnis interstitiis aequalibus rotundatis; labii interni paucis (circa 16) majoribus distantibus anticis maximis medianis ferè obsoletis, cavitate columellari parvâ albâ.

Table 1.

Measurements (in millimeters) of specimens used in this study						
Specimen and locality *	Length	Width	Height	Teeth columella	Teeth outer lip	In the collection of:
Cypraea venusta SOWERBY, 1846						
Hypotype 1	75.7	49.4	39.8	16	23	C. N. Cate (No. 563) *leg.* Max Cramer
Cypraea episema IREDALE, 1939						
Hypotype 1	78.7	48.4	42.0	6 (4)	24	Am. Mus. Nat. Hist. (No. 84083)
Hypotype 2	76.2	48.1	39.6	6 (2)	19 (1)	E. L. Fobes
Hypotype 3 (subadult)	53.0	34.6	27.8	6 (4)	19 (4)	C. N. Cate (No. 1461) *leg.* M. Cramer
Hypotype 4	63.0	40.0	32.5	6 (1)	21	C. S. Weaver; *leg.* Max Cramer
Hypotype 5	80.9	49.5	43.1	6 (3)	24	Ray Summers
Hypotype 6	79.4	51.5	43.8	6 (2)	25	Ray Summers
Hypotype 7	74.6	49.5	40.3	6 (2)	27	Ray Summers
Hypotype 8	57.4	36.4	29.4	6 (1)	22	Ray Summers
Hypotype 9	65.0	43.0	32.0	7	20	Thelma Hartley
Hypotype 10	58.0	36.0	30.0	8	20	Thelma Hartley; *leg.* Barry Wilson
Hypotype 11	61.0	41.0	33.0	8	21	Thelma Hartley; *leg.* Barry Wilson
Hypotype 12	60.9	40.1	32.9	6 (4)	25	C. N. Cate (No. 1515); *leg.* B. Wilson
Hypotype 13	60.0	39.5	32.0	6 (4)	21	Max Cramer; *leg.* Max Cramer

(4) denotes faint, immature teeth

* localities

Cypraea venusta SOWERBY, 1846

Hypotype 1	West Wallaby Island, Houtman Abrolhos Group (washed ashore west side of island, 1960)

Cypraea episema IREDALE, 1939

Hypotype 1	25 fathoms, Geographe Bay
Hypotype 2	40 feet, Geographe Bay off Dunsboro, near Cape Naturaliste, 1957
Hypotype 3	25 to 30 feet, on ceiling of cave, Sorrento Reef, Perth
Hypotype 4	With hypotype 3
Hypotype 5	15 feet, Geographe Bay; July 1960
Hypotype 6	Geographe Bay, 1957
Hypotype 7	Geographe Bay
Hypotype 8	Sorrento Reef, Perth
Hypotype 9	North Western Australia, exact locality unknown. Subfossil specimen
Hypotype 10	10 to 25 feet, Sorrento Beach, north of Fremantle. July 1, 1962
Hypotype 11	With hypotype 10
Hypotype 12	With hypotype 10
Hypotype 13	Sorrento Reef, limestone slab in soft green sponge

Shell ovate-ventricose, abruptly beaked at both ends; dorsal surface convex, flesh-colored and spotted with pale chestnut brown, lateral sides thick, flesh-colored, paler at the extremes, of more chestnut-rose color; base flattened, whitish and flesh-colored at ends; spire strongly obtuse with two whorls; aperture elongate, narrow, rather straight, inside rose-pink; the posterior canal short, sinistral; dentition of outer lip approximately 25 large subequal interstices; the inner lip with 16 teeth larger and more distant at ends and almost obsolete in the middle; columellar cavity small and white.

Sowerby adopted the name Cypraea venusta from an unpublished manuscript by Gaskoin, the whereabouts of which is unknown. The name had been associated with a unique specimen in the Saul Collection, but evidently was not published until Sowerby did so in 1846. In describing this species Sowerby provided no type figure, and specified no type locality as such, though he added this comment: "A very handsome Cowry, of which a single specimen has lately been received from Port Adelaide, South Australia." Sowerby may have recognized that Port Adelaide quite possibly was not the exact locality where the specimen had been collected, and our present knowledge of the range of the species supports his seeming hesitancy to cite it specifically.

It seems appropriate here to summarize the various references to Cypraea venusta and C. episema in their chronological sequence, to broaden the understanding of the literary histories of these species.

In 1847, one year after Sowerby's original publication of Cypraea venusta, his description was reprinted, word for word, in the Annals and Magazine of Natural History. This reference is sometimes erroneously cited as the basis for the species, but the date of actual publication of C. venusta was one year earlier. No illustration was furnished in either.

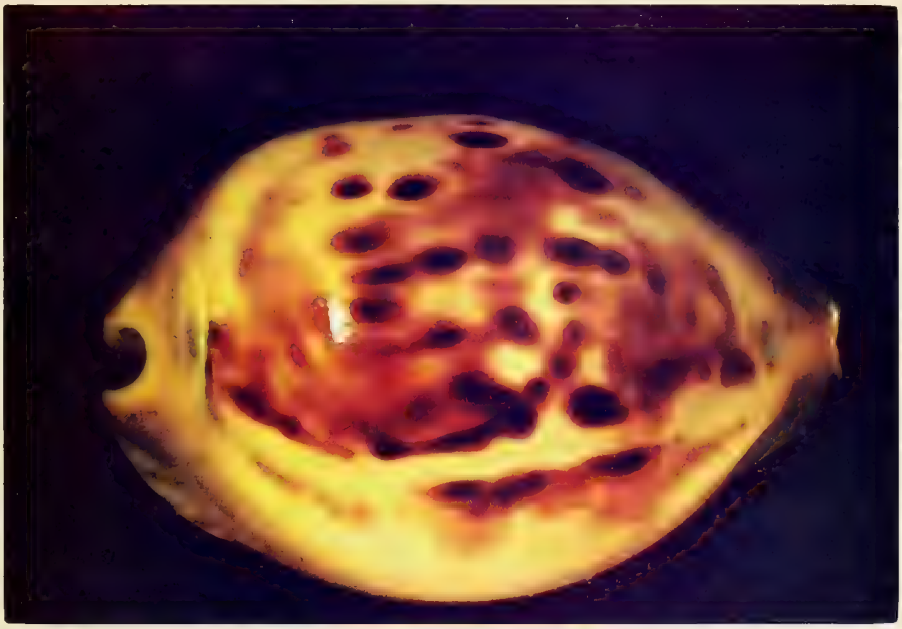
Cox (1869) described and figured Cypraea thatcheri (= C. venusta Sowerby) from two specimens collected 10 years earlier somewhere in the Dampier Archipelago, listing the measurements as: "L. 3 inches, W. 1 15/16, H. 1 11/16." Following his rather detailed description, Cox further stated: "The two specimens of this beautiful species now before me, one of which I send to be figured, were obtained by Mr. C. R. Thatcher, from a fisherman who took them at the locality above recorded, about ten years ago; and, so far as I know, no other specimens have yet been found. The two specimens are exactly alike in every way, and in a fine state of preservation. The surface of the shell is uniformly covered with a smooth shining enamel, showing no trace of dorsal opening."

Textfigure 1. Map showing the known ranges of *Cypraea episema* and *Cypraea venusta*

Sowerby (1870) grudgingly used the Cox name Cypraea thatcheri in illustrating the species in Thesaurus Conchyliorum, saying "it would have been more graceful to have applied the [Gaskoin] manuscript name." His colored illustration is an adequate representation of C. venusta, and is the type figure for the species. From his statement about the manuscript name it would appear that it was probably the elder Sowerby who described the species originally, and that the younger Sowerby was not aware of this earlier paper by his father.

Weinkauff (1881) likewise faithfully pictured Cypraea venusta in his illustration of "C. thatcheri". He converted the Cox measurements from inches to millimeters, as: L. 75 mm., W. 46 (50) mm., H. 42 mm.

Brazier (1882), referring to Cypraea thatcheri, gave the measurements as "Length 3 inches, width 1½ inches", and corrected the type locality to "Cervantes Island, west coast of Australia, not Dampier's Archipelago as first given by Mr. Thatcher." This seems to be the southernmost locality record presently known for C. venusta. Brazier's reasons for changing the measurements of the type specimen are not known, nor did he state the facts on which he



Cypraea (Zoila) venusta SOWERBY, 1846

Kodachromes by VICTOR DURAN

based his decision to change the type locality some 23 years after the specimens were collected, and 13 years after Cox cited the Dampier Archipelago. However, according to current practice, his citation of Cervantes Island as the type locality for C. venusta must remain as valid until it has been correctly revised. It would seem that a locality somewhat to the north of this point might be more typical, but much additional collecting data will be necessary before any attempt should be made to change the type locality again.

Jousseaume (1884), in establishing Zoila as a genus, designated Cypraea scottii Broderip, 1831 (= C. friendii Gray, 1831) as the type species, further designating only C. thersites Gaskoin, 1848, and C. marginata Gaskoin, 1848, to complete the genus. Cypraea thatcheri Cox (= C. venusta Sowerby) was referred at this time to another genus, Trona Jousseaume, 1884.

Roberts in Tryon (1885) cited Cypraea venusta with a brief description and a reproduction of the type figure, stating "Dampier's Is., West Australia" as its type locality, apparently overlooking the comment by Brazier mentioned above. This is the earliest mention of the name C. thatcheri as a synonym of C. venusta. Roberts erroneously referred to the 1847 publication in the Annals and Magazine of Natural History as the earliest date instead of the 1846 Linnean Society paper. While evidently using Sowerby's type figure to illustrate C. venusta in the Manual of Conchology, Roberts' brief description employs terms which now seem more applicable to a typical specimen of C. episema: "base white, teeth thick and faint purplish white."

Melvill (1888) followed Jousseaume's assignment of Cypraea venusta to Trona and compared it with C. (Trona) stercoraria Linnaeus, 1758. However, it is easy to recognize, even by a cursory comparison of their ventral surfaces, that these species belong in different subgenera. The only recognizable similarity is possibly the general bulbous appearance of each when only the dorsal aspects are considered. Melvill published the name "C. roseopunctata Sb. MSS." in this paper as a synonym of C. venusta, and C. roseopunctata thereby became a nomen nudum.

In 1889 Cox unknowingly described and illustrated a typical specimen of the species that later became Cypraea episema Iredale, 1939, erroneously referring to it as C. venusta Sowerby. In this paper he acknowledged that his C. thatcheri was a synonym of C. venusta, but he seems not to have realized that the specimen he was discussing was misidentified. Cox named the type locality as Cape Naturaliste, "where it was washed on shore with the animal in it." It is a curious coincidence that he added, "It is so unlike the type specimen [of C. venusta] that when I first saw it lying in a case of exhibits in the Melbourne Exhibition I mistook it for Cypraea thersites, having a view of its dorsal surface only, but a moment's handling of it at once revealed its true nature, unlike as it is to the type." It is this Cox paper that Iredale later cited for the original description of C. episema.

A paper by Iredale (1935) mentions a label list of Cypraeidae privately printed by Cox in 1889. I have not seen this list, but it is apparent that a varietal name "brunea" was applied therein to the species Cox had described earlier in the same year. Iredale assumed that brunea was a misspelling for brunnea, but it seems appropriate to list it here in the synonymy according to Cox' original spelling.

{Ed. note: The following was received from Dr. Myra Keen—

'Stanford University has a copy of the Cox list. Perhaps this is a later printing. It is entitled, "List of Cypraea as arranged by S. Ramond [sic] Roberts in Tryon's Manuel [sic] Conchology, intended for facilitating exchanges and labelling specimens in the collection of James C. Cox, M. D., Craig Crook, Pitt Street, St. Leonards, New South Wales, 1891." It is also marked, "For private circulation only," which is imprinted in different type style above the title.

'On page 6, under Group C, "Shell smooth, spotted, spots extending over the base" is the entry:

'"Cypraea Venusta, Sowerby	 176
= Cypraea Thatcheri, Cox	 177
Var. Cypraea Brunea, Cox	... ... added
(P. L. S. N. S. W.)"'}	

Hidalgo (1907) was the first to note specific differences between the forms we now refer to as Cypraea venusta and C. episema. He had seen the specimen of C. venusta in the Dautzenberg Collection, and thought it was possibly the same shell figured by Cox in 1869 as C. thatcheri. It was his opinion that the Sowerby 1870 figures of C. venusta did not represent the same species and pointed out certain differences in color pattern and dentition. He noted the varietal name brunea that had been applied by Cox, properly relegating it to synonymy (it was preoccupied by at least two earlier species). Hidalgo, however, did not give a new name to this different form, as he might well have done.

Gatliff (1916) described what he called a variety of Cypraea venusta, applying the name "var. bakeri." He regarded it as subspecifically different because" two faintly distinguishable white bands cross the dorsum, one being

narrower and almost central, the other at the anterior is rather broader; the remainder of the dorsum is tinted with flesh color." Gatliff illustrated his specimen well; from this figure and his description there is little doubt that he had an immature specimen of C. venusta at hand. Therefore, his variety has correctly been referred to the synonymy of that species. It is not known what has become of this specimen.

Schilder (1932) cited the various references and synonyms of Cypraea venusta appearing in the literature before that date.

Schilder & Schilder (1938) placed the species in the genus Zoila, apparently for the first time. They mentioned Cypraea thatcheri as a synonym, saying it is characterized by the white base and pale pink sides, giving its dentition formula as S. 5-6; T. 10:44-5, citing collecting stations N. W. Australia, Dampier Archipelago, and Cape Naturaliste, and listing it as rare.

Iredale (1935) cited the 1847 reprinting of the Sowerby paper as the original description of Cypraea venusta, mentioned C. thatcheri Cox, 1869, as a synonym, and "C. venusta Cox, 1889" as a variety, giving the respective type localities mentioned by each author. This was the second time notice had been taken that a different species might be the basis for the second Cox figure, but Iredale merely mentioned it at this time.

Four years later Iredale (1939) first applied the name Cypraea episema to Cox' "variety." He did not redescribe it, referring instead to the 1889 Cox work, but as this direct reference with its accompanying figure (see Plate 3, Figs. 1a, 1b) constitutes a valid description according to the rules of the International Commission on Zoological Nomenclature, the name will stand as valid. The fact that for most collectors the original description has been difficult to obtain is probably responsible, at least in part, for some of the confusion connected with this species.

Steadman & Cotton (1946) provided a complete itemized list of species and subspecies in the genus Zoila, referring Cypraea venusta and C. episema to subspecific rank under C. thersites thersites Gaskoin, 1848. This decision will be referred to again in this paper.

Schilder & Schilder (1952) provided the first complete modern discussion of Cypraea venusta, though there is no illustration in their paper of the specimen discussed (see Plate 4, Figs. 1 to 3). They mentioned it as very rare, from the Dampierian Region; the dentition formula was given as 75 (66) 17:12. The remainder of this note is quoted here in full: "Dampier. (Sowerby and Fulton): 1 ex: 74 (63) 17:12 (25 labial and 15 collumellar [sic] teeth); dorsum pale pink, with reddish orange spots, which are different in size, but rather round and not confluent, extremities greyish pink, sides pinkish white, base white, but fulvous along the margins. Dautzenberg's label runs as follows: 'Cet exemplaire a été figuré in Proc. Zool. Soc. London, 1869, pl. 26, fig. 1', therefore one would think it to be the holotype of thatcheri Cox. This figure, however, which is reproduced by Roberts in Tryon, Man. of Conch., 7, pl. 10, fig. 44 and 45 (1885) does not quite agree with Dautzenberg's shell: the arrangement of the dorsal spots is different, as is the number of teeth (24 labial, 14 columellar teeth), and all features of the anterior extremity, especially regarding the terminal ridge, which is obsolete in Roberts' figure, but distinct and followed by a smaller intercalated denticle in Dautzenberg's shell; therefore, Dautzenberg's shell can be regarded at most as the paratype mentioned by Cox (Proc. Zool. Soc. London, 1869, p. 358, 1869).

"This species, bought by Dautzenberg [March 12, 1904] for £24/--/--, is extremely rare; we have seen but one shell each in the British Museum and in coll. Saul (Cambridge), and very few other specimens have been collected in North Western Australia."

In 1956, Allan placed the two similar species, Cypraea venusta and C. episema, in different categories, C. venusta as a full species and C. episema as a subspecies of C. thersites Gaskoin, 1849 (sic). Cypraea venusta cannot be a subspecies of C. thersites, notwithstanding this and the earlier decision by Steadman & Cotton; C. venusta has two years' priority over the latter name, though Allan points out that she and Iredale regard both C. venusta and C. episema as subspecies of C. thersites. If this line

Explanation of Plate 2

Figures 1a and 1b. *Cypraea venusta* Sowerby, 1846. Hypotype No. 1, *ex* C. N. Cate Collection
Figures 2a and 2b. *Cypraea episema* Iredale, 1939 Hypotype No. 1, *ex* Am. Museum of Natural History Collection
Figures 3a and 3b. *Cypraea episema* Iredale, 1939. Hypotype No. 2, *ex* E. L. Fobes Collection

Figure 3 a

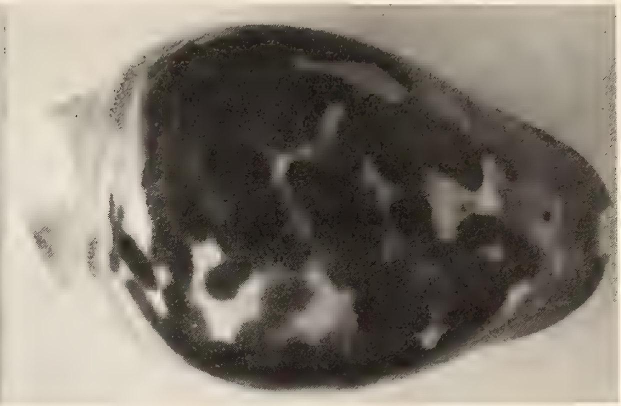


Figure 3 b

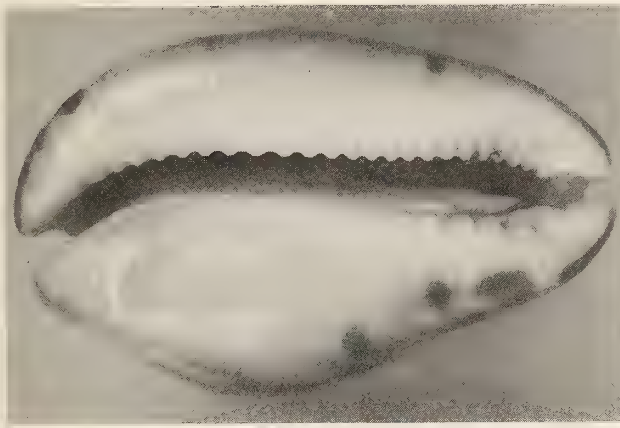


Figure 2 a

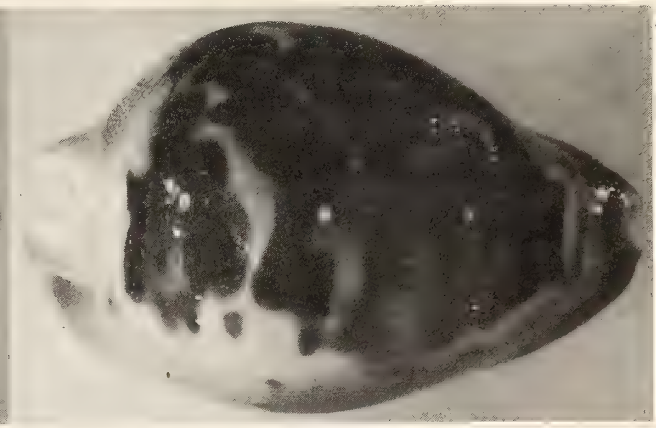


Figure 2 b

Figure 1 a

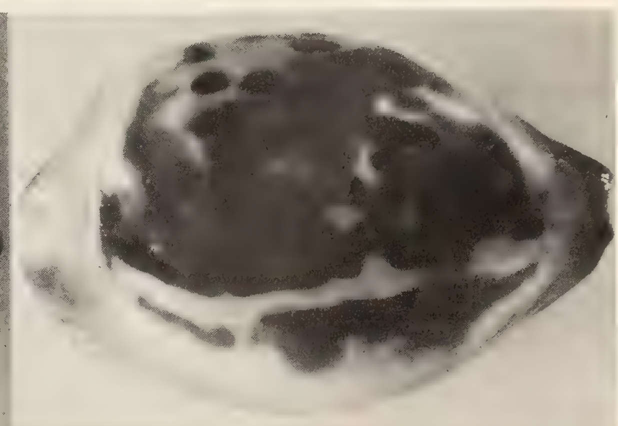


Figure 1 b

TAKEO SUSUKI, *photo.*

of reasoning were followed and the two species discussed here were related this closely to C. thersites Gaskoin, a major change in the systematic arrangement of the Zoila species would be necessary, according to the rules of priority. The result would be: Cypraea venusta venusta Sowerby, 1846 (typical species); C. venusta thersites Gaskoin, 1848; C. venusta contraria Iredale, 1935; and C. venusta episema Iredale, 1939. In this 1956 paper Allan discusses the differences between the two "subspecies" rather fully, illustrating, however, only C. venusta.

Schilder (1960) considered Cypraea episema a "good species which was fished at Fremantle at the same time as friendii. It is easily distinguished from thersites by the whitish base, with brownish short lines on the teeth themselves (instead of the lines extending from the outer margin toward the aperture), the lighter colored sides with the more sharply defined dark spots, the dorsally less sharp-edged canals as well as the inner lip which is externally impressed at one-quarter and three-quarters of the length. Among the Zoila, Z. episema is closest to the deep-water form venusta."

In 1961, Summers published a discussion of the two rare species though it now appears that all the specimens he used in his evaluation of them are Cypraea episema, one of these being an intrapopulation variant which will be discussed later in this paper.

In September 1961, Weaver published three photographs of a freshly collected Cypraea venusta, the same specimen used in this study (see Plates 1 and 2, Figs. 1a, 1b).

In October 1961 (p. 110) Schilder ambiguously lumped both species together under Cypraea venusta despite having considered them separable in his 1960 paper.

Discussion

The two species under discussion have evidently been correctly assigned to Zoila, which I prefer to consider as a subgenus of Cypraea rather than a full genus. Cypraea venusta and C. episema are perhaps more closely related to one another than are the others in that group, but still seem distinct enough to be considered separate species, at least until enough living specimens can be obtained to make possible a complete study of the anatomies of both forms. It is my opinion that their relationship to C. thersites is only as members of the same subgenus.

In classifying the Zoila, I would consider that the subgenus consists of four monotypic species and two polytypic species, the subspecies of the latter two being merely polytopic variants. Schilder's Prodrome (1938-1939), listing Cypraea thersites, C. vercoi, and C. contraria as subspecies of C. friendii friendii has evidently been revised by his 1961 paper, which implies the same taxonomic revision of the Zoila species as I have suggested here, except for the inclusion of C. episema. The subgenus would therefore be arranged in the following manner:

Cypraea venusta Sowerby, 1846
Cypraea marginata Gaskoin, 1848
Cypraea decipiens Smith, 1880
Cypraea episema Iredale, 1939
Cypraea friendii friendii Gray, 1831
  Cypraea friendii vercoi Schilder, 1930
Cypraea thersites thersites Gaskoin, 1848
  Cypraea thersites contraria Iredale, 1935

In considering the reasons for the close similarity of the two species, one interesting possibility came to mind, namely, that they might be convergents from separate fossil ancestors. However, a search of the limited amount of paleontological literature available to me (for West Australia) revealed no known fossil species even faintly resembling Cypraea venusta or C. episema; therefore, until further records can be studied, it will have to be assumed that they are both of Recent origin.

An interesting discovery was made in the course of pursuing this study: the occurrence of a variant of Cypraea episema (see Plate 3, Figs. 2a, 2b, 3a, 3b) evidently restricted to the area of Sorrento Reef. This variant resembles the typical adult C. episema in all respects except that it is generally smaller and darker than specimens collected at stations farther south. Remarkably uniform as a group, the Sorrento Reef shells can be separated from other specimens of C. episema at a glance; they are considerably smaller (from 53 mm. to 63 mm. as compared to the 74 mm. to 80 mm. of typical C. episema), proportionately lighter in weight for their size, more compact generally and with a rich, nearly solid-patterned, almost black dorsum. A personal note to C. S. Weaver from Max Cramer of Geraldton, Western Australia, says in part: "I am sending my episema which came from Sorrento Reef just north of Perth in 30'-40' of water on a limestone reef. I have seen others and my specimen is smaller than most, but all taken in that area are about the same size. . .The Bunbury ones are large. . ."

Mr. Cramer's statement further corroborates the occurrence of a variant in this northern segment of the range of C. episema. It is my opinion that the existence of this variant has been another possible cause for much of the confusion between Cypraea episema and C. venusta: at first glance the two forms of C. episema seem different enough that it is easy to understand how one could consider them two separate species, especially since there were no readily available illustrations or type figures to make determinations possible. On closer examination, however, their morphological characters are almost identical except for size and coloration. Since C. venusta is relatively a much rarer species, not available generally for comparison, it could be considered a logical conclusion that the "different" northern form was probably C. venusta, as a similarity between C. episema and C. venusta had been noted, and the northern collecting stations approached within approximately 100 miles of the known southern limits of C. venusta's range.

Adult shells from the general area of Geographe Bay (see Plate 2, Figures 2a, 2b, 3a, and 3b) (including Cape Naturaliste) are consistently larger and are giants by comparison with the Sorrento Reef variant. They are much heavier, more solid shells with a typically lighter, more scattered dorsal pattern. Further study will be necessary to discover the reason for this abrupt change in the species within so short a distance; it is possible that a temperature change and other ecological factors may be in part responsible for it. Perhaps the most significant fact about the variant's existence is the wedge-effect it has in separating the ranges of typical Cypraea episema and C. venusta.

The known range of Cypraea episema (see map, Textfig. 1) is from Geographe Bay northward to Sorrento Reef, roughly 40 miles north of Perth. The southernmost record for C. venusta is approximately 100 miles north of this point, at Cervantes Island; it ranges northward through the Houtman Abrolhos Group to (possibly) the Dampier Archipelago. So few specimens of C. venusta have been recorded that no more definite range limits can be established at present; most of the early literature merely cites "North West Australia" as the typical locality. Brazier's (1882) citation of Cervantes Island established the type locality of C. venusta, and Cape Naturaliste, mentioned by Cox in 1889, was apparently accepted by Iredale as the type locality for C. episema.

The holotype of Cypraea venusta is in the type collection of the British Museum (Natural History). Other known specimens are in the Dautzenberg Collection (Brussels), the Saul Collection (Cambridge), and the Cate Collection (Los Angeles). At least one other specimen exists in Australia, presumably in the museum at Albany, Southwest Australia. Another specimen or two are rumored to exist in the United States, but those listed here are the only verified specimens I am able to cite at this time.

The holotype of Cypraea episema is Number D3'980 in the South Australian Museum at Adelaide. This species is more widely represented in collections than C. venusta, though still of uncommon occurrence. Many of the known specimens are listed here in Table I. In a recent personal letter to me, Max Cramer mentions that he knows of the existence of four additional specimens. It is hoped that the present discussion will bring to light additional records of both species.

My own specimen of Cypraea venusta (see Plates 1 and 2, Figs. 1a, 1b) is considerably different morphologically from all of the other shells examined in this study. It fits Sowerby's description very well, and since, as mentioned earlier, it was impossible to obtain a photograph of the holotype, the Sowerby (1870) type figure was my only dependable reference point. The only difference between the type figure and my specimen is a slightly greater emphasis on the central two or three columellar teeth in the Sowerby illustration than seems appropriate; these teeth exist on my specimen, but they are very faint. Sowerby's description mentions these teeth as "almost obsolete in the middle" —a condition not readily apparent from the type

Explanation of Plate 3

Figures 1a and 1b. Reproduction of type figure of *Cypraea episema* IREDALE, 1939

Figures 2a and 2b. *Cypraea episema* IREDALE, 1939 (Sorrento Reef variant) Hypotype No. 4, *ex* C. S. Weaver Collection

Figures 3a and 3b. *Cypraea episema* IREDALE, 1939. (Sorrento Reef variant) Hypotype No. 3, (subadult) *ex* C. N. Cate Collection

Figure 1 a

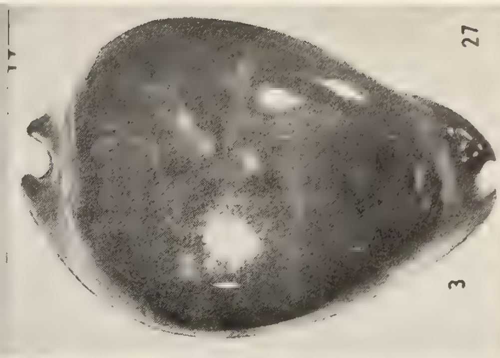


Figure 1 b

Figure 2 a

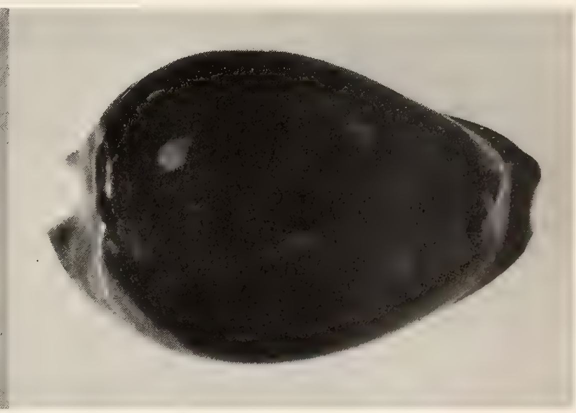


Figure 2 b

Figure 3 a

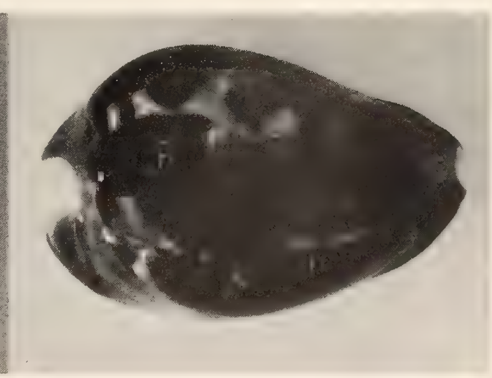


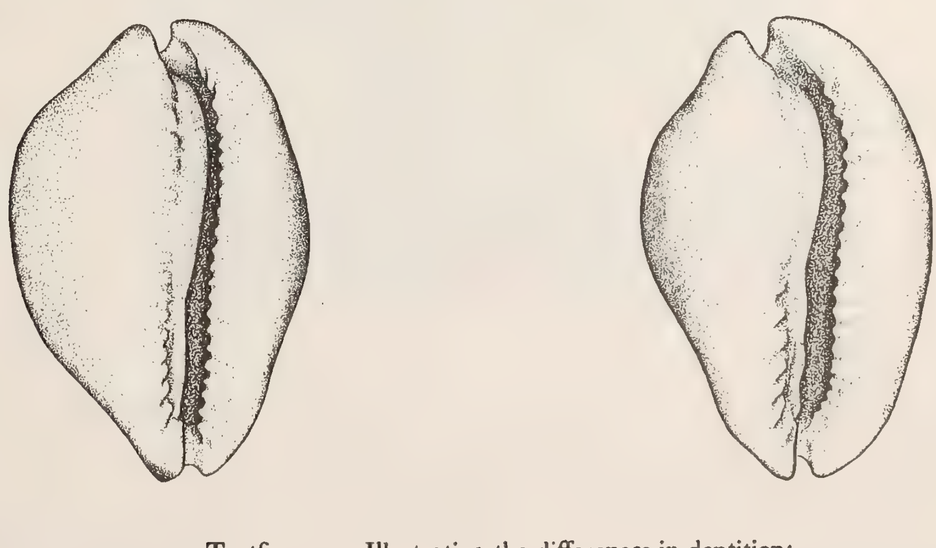
Figure 3 b

TAKEO SUSUKI, *photo.*

figure, but easily seen in my specimen and in the Dautzenberg specimen in the Institut Royal des Sciences Naturelles de Belgique (see Plate 4, Figures 1 to 3). In C. episema the columellar teeth are discontinuous, becoming entirely obsolete in the middle. It is possible that the artist wished to show the presence of the suggestion of teeth, but overdid the emphasis slightly in his drawing. This most important difference between the two species can be observed from the two drawings in Textfig. 2.

Cypraea venusta differs from C. episema in being solid, humped anteriorly as well as to the rear; the bodywhorl is longer, more cylindrically ventricose; the base and lip both slope concavely toward the aperture; the teeth are well defined, more numerous, numbering 16 on the columella. On the outer labial edge they are short, strong, with narrower interstices, more color, and number 23. The columellar teeth are finer, shorter abaperturally, extending well onto the fossula; the aperture is straighter, narrower, less curving, and constricted abapically; the shell's extremities are more blunt; the color is basically rose-beige, copiously marked with large, deep, somewhat blurred chestnut spots and channels, many indistinct, others intermingled in various shades of brown; the sides above the margins are of varying intensities of grayish-pink, vertically rayed with striae; the left margin (only) has widely scattered, medium-sized brown spots; the base, teeth, and interstices differ further in being more colorful — a pale golden-orange tint, darker approaching the margins; the interior of the shell is a rosy-pink. A final difference is the wide, distinct mantle line of the basic color of the shell which traverses the right dorsum.

The distinguishing features of Cypraea episema are also readily recognizable. The shell is obconically ovate, humped adapically, sloping in a more gradual manner toward the front, moderately ventricose in the adapical hump. The sides are more acute and sharply angled; the margins are more thickly developed with a broad callus. The base is wider, noticeably so just to the rear of the center, and only very slightly concave adaxially. The columellar teeth are shorter, broader, club-like, less numerous, mainly confined to the abapical third of the columella, and are six in number. (On immature shells the columellar denticles may be more numerous, though mostly becoming obsolete with maturity.) Unlike C. venusta, they do not overlap onto the fossula. The aperture is wider, curving more abruptly adapically. The extremities are heavier and more produced; C. episema differs further with a basic off-white to white color, more heavily marked (though not solid, except in the Sorrento Reef variant where the dorsum is nearly a solid brownish-black) with a diffused pattern of varying darker color intensities of deep chestnut brown. This species differs further in that the marginal callus striae are lateral rather than vertical; both right and left margins are spotted; the base, teeth, and interstices are white with occasionally a faintly perceptible brown tint on the crest of the teeth. There is no mantle line.



Textfigure 2. Illustrating the differences in dentition:
a. *Cypraea venusta* Sowerby, 1846
b. *Cypraea episema* Iredale, 1939

Conclusions

To sum up my conclusions from the foregoing study, it is my opinion that, pending further information from fossil records, locality data, ecological enlightenment, the study of live-taken animals, and other considerations, Cypraea (Zoila) venusta Sowerby and C. (Z.) episema Iredale are distinct species, separable chiefly by morphological differences. It is an admitted possibility that further facts may come to light that could change this opinion.

As a final note I should like to point out, for the benefit of those interested in comparing their specimens with the color plate included here, that the color has been rather faithfully reproduced and can be accepted with confidence as a fairly accurate representation of the color of a recently collected specimen of Cypraea venusta. If there is any deviation from the color of the actual specimen, it is perhaps slightly more yellow than the true color.

Acknowledgment

To the many already mentioned who have assisted me in the research necessary for this paper I wish to add the name of Dr. Rudolf Stohler, who provided an important translation of the Schilder (1960) paper. I extend my grateful thanks to all of them, and especially to Jean Cate for her help and encouragement.

Mrs. Emily Reid of The Veliger staff provided the excellent textfigures; except as otherwise noted, the photographs are by Takeo Susuki.

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Explanation of Plate 4

Cypraea venusta Sowerby, 1846

Figure 1. Ventral aspect. Figure 2. Dorsal aspect. Figure 3. Lateral aspect. Specimen in Collection Dautzenberg. Photographs through the courtesy of the Institut Royal des Sciences Naturelles de Belgique.


Figure 1


Figure 2


Figure 3

Historical Zoogeographic Study of the Clavagellacea

BY

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(2 Textfigures)

Introduction

The restudy of this unusual pelecypod group, often referred to as the "watering pot" shells, was undertaken as a revision for the "Treatise on Invertebrate Paleontology" in which a resumé of the taxa and types of the superfamily will appear. A more complete review of the group was published in The Veliger, volume 4, number 4 (Smith, 1962).

During the investigation it was necessary to compile data on the relationships of over 100 species of the group. Interesting and somewhat puzzling distribution patterns emerged for species and higher taxa in both time and space. I am, therefore, attempting an analysis of the distribution patterns in the light of modern zoogeographic thought.

Apparent rarity of the clavagellids during all of their geologic history makes it difficult to arrive at other than hypothetical conclusions. There are no large numbers of fossil remains nor of living forms upon which to base statistical analyses. Sparsity of the animals at any one time, and perhaps also difficulty of preservation in their usual habitats, have left pitifully incomplete the record of their geologic history. One is further hampered by incomplete studies of geologic sections in areas of clavagellid distribution outside Europe.

The present study should at least point up the necessity of taking into consideration the geologic record in zoogeographic investigations, regardless of the incompleteness of that record. In the case of clavagellids, restriction to data on the Recent species would give the reverse of what is probably the true history of the group. There are only four species living outside the Indo-Pacific-Australasian region, yet most of the group's geologic history is recorded in the strata of Europe. Indeed, it would be difficult to explain the present distribution without some knowledge of past occurrences.

Historical zoogeography is neither clearly a means nor an end. It must depend upon almost every other discipline of the geologic and biologic sciences. The historical zoogeographer is accountable for the consideration of an ever-increasing bulk of data, from paleontology to pollution studies. At the present time he is torn between revelling in the tremendous volume of available data and being crushed by its mass. After consideration of the already formidable amount of data, he attempts to integrate his own and thus adds to the task of those who follow.

The extreme importance of both temperatures and land-mass distribution in the control of shelf faunas requires the careful consideration of paleoclimates and paleogeography, each of which is a synthesis of data from multiple-discipline approaches. Historical zoogeography must both use and test the earlier findings of diverse and often seemingly alien workers.

Relationships and Distribution

The two figures following will summarize as briefly as possible the findings of the earlier study (Smith, loc. cit.). Figure 1 diagrammatically represents the development of the clavagellids throughout their known geologic history. Morphology and geographic distributions suggest that the penicillids arose in Early Tertiary from Clavagella (Stirpulina) and that the rock-dwelling forms are later developments from Clavagella s. s.

Figure 2 shows the change in geographic distribution of the group's members with advancing time. The eastward shift during later Tertiary times is evident. The available geologic record indicates that the group inhabited mainly European waters until Late Oligocene. Bryopa is the only known survivor west of the Red Sea.

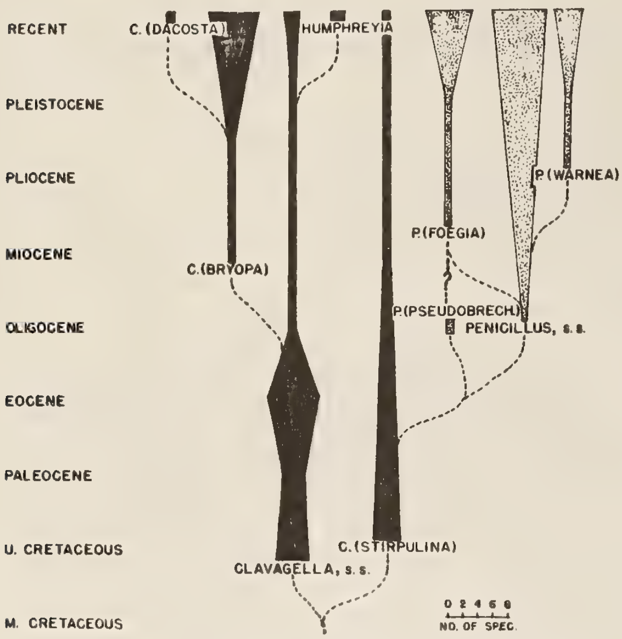

Figure 1. Temporal distribution of Clavagellids and probable evolutionary development

Modern clavagellids inhabit mainly clear shallow seas in subtropical shelf areas. The center of present-day clavagellid distribution lies in the vast areas of submerged shelf surrounding the Indo-Malay archipelago, from southern Japan to the northern shores of Australia, and as far west as the Mediterranean.

It is important to note that, as members of the subtropical shelf faunas, the clavagellids must have required temperature and land area distributions differing from those of the modern world to allow (or force) their eastward movements during Middle to Late Tertiary times. Affinities have been noted in many animal groups between inhabitants of southwestern Mediterranean and subtropical Japanese waters. Numerous fossil occurrences of their relatives in present-day land areas such as India also attest to the presence of a former connecting seaway. This ancient water body — the Tethys Sea — extended, approximately through the modern Mediterranean area, from eastern North America to southern Asia, and existed from Early Mesozoic to Middle Tertiary times.

Historical Zoogeography of the Clavagellids

During Late Cretaceous time continental terrestrial areas were considerably restricted, and the areal extent of epicontinental seas was greater than at any time since Ordovician (Zeuner, 1945). The continents were comparatively featureless, rather uniformly low in elevation. Tropical to subtropical floras occupied most of the southern two-thirds of the United States (MacGinitie, 1958). According to Durham (1950), the February isotherm of 18° C. must have been located at about 53° N. Lat., approximately 1'500 miles north of its present location on the coast of Baja California. Suggested warmth of the seas would be sufficient to push subtropical faunas to the northern limits of the Tethys seaway.

The Tethys existed for much of geologic history; but, being considerably north of the equator, it perhaps provided east-west passage of tropical, and to some extent subtropical, marine faunas only during warmest times, e. g., Late Cretaceous to Late Eocene. According to Schuchert (1935), there existed shallow shelf areas bordering continuous lands which connected the European (about present-day Spain) with the North American region (about New York). During the warm Late Cretaceous, this could have provided the westward migration passage for subtropical shelf faunas necessary for the appearance of Clavagella (Stirpulina) armata Morton in the Late Cretaceous of New Jersey. Continued warming then perhaps forced them back to the northeast along the coast beyond the limits of the present North American continent, and thus outside the areas of our present exposures of younger strata. Similarly, the Tethys seaway provided even easier access for subtropical shelf faunas to the northern Indian area during Late Cretaceous, as the connection of India with the Mediterranean region

	NORTH AMERICA	EUROPE	AFRICA	RED SEA	INDIA	INDO-PACIFIC	JAPAN-PHILIP.	AUSTRALASIA
RECENT		C.(B.)		P.(Pe.) P.(W.)		C.(B.) P.(Pe.) P.(F.)	C.(C.) C.(S.) P.(Pe.) P.(F.) P.(W.)	C.(C.) C.(B.) C.(D.) H. P.(Pe.) P.(F.) P.(W.)
PLEISTOCENE						P.(Pe.)		
PLIOCENE		C.(C.) C.(S.)		P.(Pe.)		P.(Pe.) P.(F.)	P.(F.) P.(W.)	
MIOCENE		C.(S.)			C.(C.)	P.(Pe.) P.(F.)	P.(F.)	
OLIGOCENE		P.(Pe.) C.(B.) C.(C.) C.(S.)		C.(S.)		P.(Pe.)		
EOCENE		C.(C.) C.(S.)						
PALEOCENE		C.(C.)						
U. CRETACEOUS	C.(S.)	C.(S.) C.(C.)	C.(C.)		C.(C.)			

Figure 2. Geographic distribution of Clavagellids from Late Cretaceous to Recent

is well established. This should adequately explain the presence of Clavagella (Clavagella) semisulcata Forbes in Late Cretaceous strata of India.

Questionable Middle Cretaceous occurrences of Clavagella s. s. and its morphology suggest that it is the original stock and perhaps developed in the shelf areas of warm shallow seas of southern Europe. The lack of records from the southern hemisphere suggests that it was not a tropical form but originated in the northern subtropics prior to the Late Cretaceous-Early Tertiary temperature maximum.

Continued warming and access to the entire Tethys seaway suggest the possible avenue for eastward migration of Clavagella s. s. (to India) and westward migration to North America of the then new C. (Stirpulina) branch. As the only living Stirpulina is found in Japanese waters, it may be inferred that it was tolerant of slightly colder waters and was thus able to negotiate the more northerly route to North America, whereas Clavagella s. s. could not. The suggestion that Stirpulina was the colder water form of the two is strengthened by the fact that in the cooler Pliocene the animal was still living in Central Europe, whereas Clavagella s. s. is not found in Pliocene strata outside the Italian peninsula.

Paleocene - Eocene

"Existent bitter arctic conditions around the poles would not be possible with the indicated oceanic temperatures of Late Cretaceous and Early Tertiary times" (MacGinitie, 1958). Chaney (1947) reported evidence which indicates the existence of temperate deciduous forests around the North Pole ranging in age from Paleocene to Middle Eocene. Durham (1950) concluded that during the Eocene, the 18° C. isotherm was between 53° and 55° North Latitude, even farther north than during Late Cretaceous. Tropical floras existed along the Gulf of Mexico during Early Tertiary and shifted northward, the advance culminating in Late Eocene (Chaney, 1947).

After spreading as far as India and eastern North America during Late Cretaceous, no Paleocene or Eocene records of clavagellids are known from areas outside Europe. This suggests that, for some reason, east-west migration was halted by the end of Cretaceous and the group was forced to withdraw to the European region. The configuration of the northern shores of the Tethys seaway may be offered as a reason for the apparent withdrawal to the central area. Since the clavagellids were apparently members of the subtropical shelf faunas, the continued rise in temperatures through Eocene would force northward migration (northwest from India and northeast from North America) along the northern arc of the Tethys Sea. This hypothesis is negatively supported by the lack of Eocene occurrences in southern Europe. It would be positively supported by the discovery of Eocene clavagellids in Greenland and on the Scandinavian peninsula.

Oligocene

Emiliani (1958), from his study of deep sea cores, has indicated that in the Pacific abyssal equatorial temperatures of Middle Oligocene were about 10° C., and present-day circulation patterns suggest that temperatures must have been little less in the polar seas. Although polar winter snows would be probable, permanent ice caps would be impossible under such conditions. The time from Early Oligocene to the first glacial stage of Pleistocene is marked by a gradual cooling and drying of climates (MacGinitie, 1958).

The decline of temperatures in Oligocene again allowed south and southeastward migration of the subtropical shelf faunas. Perhaps discontinuous land and shelf areas existed between Europe and North America, effectively restricting a remigration to the west. Clavagellids returned to southern Europe and northeastern Africa, and three new branches developed to take advantage of the available environments.

Penicillus s. l. probably developed in the northern Tethys, perhaps during Early Oligocene. Continued lowering of temperatures would have brought it south into Europe (Pseudobrechites) and southeastward along the unbroken northeastern shore of the Tethys Sea into the Indo-Pacific region (Penicillus s. s.). The form Bryopa developed in the southern European area in Late Oligocene, perhaps replacing some tropical form which was probably forced to abandon its niche among the declining reef corals as the lowering of temperatures continued. The continued increase of climatic extremes apparently eliminated Pseudobrechites in the south-central Tethys and left Penicillus alone in the Indo-Pacific area, from which all later penicillids must have branched.

Neogene and Quaternary in Europe

According to Durham (1950), the 18° C. isotherm had moved down the west coast of America to the approximate latitude of northern California by Early Miocene. This indicates the continued lowering of general oceanic temperatures which eventually brought about the decline of the tropical and subtropical Tethys faunas in the European area. This is evidenced by the restriction of many groups such as the reef corals, and their migration into the Indo-Pacific region (Gerth, 1925, in Ekman, 1953).

During Miocene times Clavagella s. s. appeared in the Indian region, probably moving southeastward with other subtropical elements of the Tethys fauna. During Pliocene only Stirpulina remained in the central European area, and Clavagella s. s. was effectively restricted to the southern extremities of that continent.

Bryopa, which developed during cooler times than other clavagellids, was the only form to survive Pleistocene coldness in the Mediterranean region. It is possible that, since Bryopa migrated with other faunas into the Indo-Pacific region before effective closing of the Tethys seaway, it may have been reintroduced into the Mediterranean through the Red Sea during an interglacial stage of Pleistocene. There is, however, no supporting evidence from Pleistocene strata for such a supposition.

Early Neogene in the Indo-West-Pacific

The Oligocene introduction of Penicillus s. s. into the Indo-Pacific region opened new vistas for the development of the penicillid branch. Clavagella s. s., Bryopa, and Stirpulina survived the migration also but were probably equatorially restricted much earlier than the newer forms. Penicillus, which developed during cooler Middle Tertiary time, was apparently able to make the most of vast shelf areas of the Indo-Malay region for rapid spread and the development of several new branches.

During Miocene the penicillid Foegia developed in the Indo-Malay area and migrated northeastward into the southern Japanese and Philippines region. Clavagella remained along the shores of the Indian Ocean and Penicillus s. s. developed new species and spread through the Indo-Pacific.

Pliocene

Axelrod (1956, 1957) has suggested from paleobotanical evidence that average temperatures at the beginning of Pliocene differed little from those of today but suggested that the temperature range was considerably less in the western United States (more equable climates). However, the northern oceans were apparently still warmer than those of today, as Durham (1950) suggests a position for the 18° C. isotherm at 35° N. Latitude, some 5° to 6° north of its present location. From distribution studies of fossil pulmonates, Frye & Leonard (1957) concluded that conditions of seasonal climates essentially like the present day were attained by Late Pliocene.

A third penicillid group (Warnea) appeared in the South China Sea and is recorded from Pliocene strata of both Formosa and southern Japan. The Red Sea, much as we know it today — though a little cooler — came into existence during Pliocene, and equable climates allowed considerable spreading of the more eurythermal forms.

Penicillus s. s. migrated into the Red Sea from the Indian Ocean. The higher than normal temperatures of that body of water were perhaps extant even then and may have made it possible for Penicillus to remain there until the present day.

Pleistocene

During the glacial stages the zone of maximum cyclonic activity was even farther south than at present. Southward movement of the polar front and increased temperature gradients caused pluvial conditions in the zone just south of the glaciated area during glacial periods (MacGinitie, 1958). Manley (1955) indicated that north-south temperature gradients may have had at least double the present value. During such times of cyclic climatic changes, the stimuli to admixture, hybridization, and natural selection must have been greatly intensified (MacGinitie, 1958).

During periods of intense glaciation, all clavagellids except Stirpulina were probably restricted to a narrow equatorial zone, being allowed northward and southward migration only during interglacial warming. Only such a distribution would effectively explain the present-day bipolarity of all except Stirpulina and branches developed during Recent times.

Recent

A gradual warming of world climates culminated in the so-called "Climatic-Optimum" about 6 000 years ago, followed by a return to the cooler conditions of the present day. Now, warming seems to have been renewed (MacGinitie, 1958), resulting in the spread of tropical deserts from western India across the Mediterranean and northern Africa, and in the southwestern United States (Wadia, 1955).

The Recent so-called "Climatic Optimum" (actually a post-Pleistocene interglacial stage) probably brought about bipolarity in most of the formerly equatorial groups. Gradual cooling has since allowed equatorial mingling of the essentially tropical forms.

Two new groups, Humphreyia and Dacosta, have developed on the Australian coasts, probably from the clavagellid line. Warnea probably migrated around the shores of the Indian Ocean and into the Red Sea during an interglacial stage, or perhaps during the Early Recent warming. Subsequent cooling has eliminated it from intermediate areas, but adjacent desert conditions have maintained higher than normal temperatures in the Red Sea and Warnea has survived there.

Acknowledgment

This study was made possible through access to the library and museum facilities of Stanford University, the California Academy of Sciences, and the University of California at Berkeley. Grateful acknowledgment is extended to Dr. Myra Keen for continuous advice, assistance, and encouragement during the investigation and for critically reading the final manuscript. However, the writer accepts full responsibility for any errors of transcription or of judgment.

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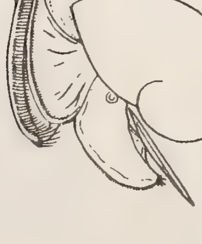

A New Species, Genus, and Family of Marine Flatworms (Turbellaria: Tricladida, Maricola) Commensal with Mollusks

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(3 Textfigures)

Introduction

The animal described in this report brings to three the number of marine triclad turbellarians described from the Pacific Coast of North America. In his monograph of triclads, Wilhelmi (1909) described all the marine species known up to that time. Since 1909 new species of the Maricola have been added by Hallez (1911, 1913), Böhmig (1914), Hyman (1944, 1952, 1954, 1956), Marcus (1947, 1948), and Westblad (1952). In 1954 Hyman described the first marine triclad known from the Pacific Coast of North America, a member of the Procerodidae, Procerodes pacifica, which was collected near San Diego, California. In 1956, a second, Nesion arcticum, representing a new family, the Nesionidae, was described from Alaska by Hyman.

The animal described below differs from all known marine triclads in an interesting and significant feature. The ovovitelline ducts enter the roof of the penis bulb. This unique feature makes it necessary to establish a new family, genus, and species.

Materials & Methods

The first specimens of the present triclad were collected one mile south of Stinson Beach, California, in 1956. About 70 specimens were collected at various times over the next several years and were preserved in Bouin's fixative. Eight additional specimens were received from Clinton A. Westervelt, Jr., of Lewis and Clark College, Portland, Oregon; 22 specimens were received from Howard Wright of the University of California, Berkeley; and 18 specimens from Dr. Dana Abell of Sacramento State College. Ten whole mounts were made and stained with aceto-carmine and counter-stained with fast green. Serial sections were cut in paraffin at 7 and 10 microns. A number of sets of serial sections were stained in alum-hematoxylin and counter-stained in eosin. Ten sets of serial sections were stained by the periodic acid-Schiff technique..

Systematics

Nexilidae, new family

Maricolous triclad turbellarians with ovovitelline ducts entering the penis bulb.

Nexilis Holleman & Hand, gen. nov.

With the characters of the family. Type: Nexilis epichitonius, spec. nov.

Nexilis epichitonius Holleman & Hand, spec. nov.

The mature living specimens are 3 mm. long and 1.5-2.0 mm. wide. Flattening during fixation may distort the shape so that the specimens may be slightly longer (4 mm.) and wider (3 mm.). The living specimens are white except for the black eyes and the gut which is dark blackish-brown in color. Auricles are absent. Two eyes are located a short distance from the anterior margin, directly in front of the brain. Sections through the eyes show that they are pigmented ocellar cups without lenses. The epidermis is ciliated dorsally and ventrally.

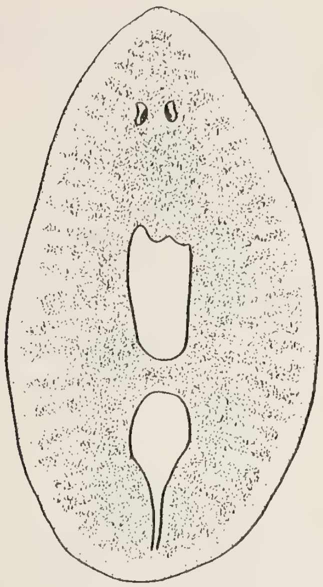

Figure 1: *Nexilis epichitonius* HOLLEMAN & HAND, gen. et spec. nov.; drawn from a living specimen (specimen 2.5 mm.long)

The male part of the reproductive system consists of four pairs of ventral testes segmentally arranged in a bilateral distribution. The members of the pairs are separated from one another by the anterior branch of the gut. The testes are located directly behind the ovaries. The sperm ducts run ventrally from the testes and posteriorly, parallel and medial to the ventral nerves, past the pharyngeal cavity, then upward in an S-shaped curve to enter separately into the seminal vesicle. The seminal vesicle connects with the large cavity, the bulbar lumen, within the base of the penis by means of a minute canal within a papilla which protrudes posteriorly from the posterior wall of the seminal vesicle. The papilla has a muscular appearance.

The female part of the reproductive system consists of a pair of ovaries located directly behind the brain and anterior to the testes. The ovovitelline ducts run posteriorly along the course of and lateral to the ventral nerves. Along the length of the ducts vitellaria can be observed. At the posterior end of the pharyngeal cavity, the ovovitelline ducts converge dorsally to a point directly above the enlarged proximal maximal area of the bulbar lumen. At this point the ovovitelline ducts unite to form a common ovovitelline duct. The common ovovitelline duct enters the roof of the bulbar lumen. Located around the common ovovitelline duct are glandular structures which are interpreted as cement glands. Egg capsules have been observed in living and preserved specimens and in sectioned material. The egg capsule occupies the enlarged proximal maximal area of the bulbar lumen. When the egg capsule is present, the seminal vesicle is compressed anteriorly and the penis bulb and penis papilla are distended posteriorly. Discharge of the egg capsule has not been directly observed, but living specimens have been observed a short while after discharge of the egg capsule. Evidence of rupturing of the body wall for the discharge of the egg capsule has not been found, but observations suggest that the egg capsule is passed down the ejaculatory duct and discharged through the common gonopore. This passage of the egg capsule is probably aided by the extensive musculature of the penis bulb and penis papilla.

Within the ovaries are developing oocytes and eggs. Sperm have been observed at the exit of the ovovitelline duct from the ovary, and in some specimens sperm have been observed in the ovary proper.

An occasional variation in the arrangement of the testes has been observed. The variation consists of: first, three pairs of testes segmentally arranged in a bilateral distribution; second, three testes located on one side of the gut and four on the opposite side; the remaining variations were three and five, three and six, and finally four and five testes on opposite sides of the body.

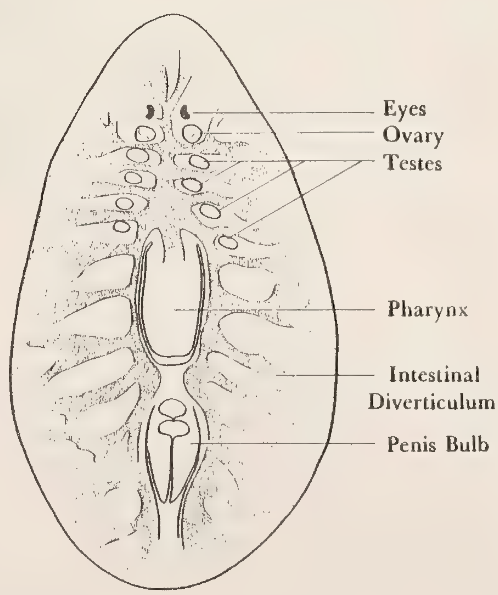

Figure 2: *Nexilis epichitonius* HOLLEMAN & HAND, gen. et spec. nov.; drawing from a cleared wholemount to show the distribution of the gonads.

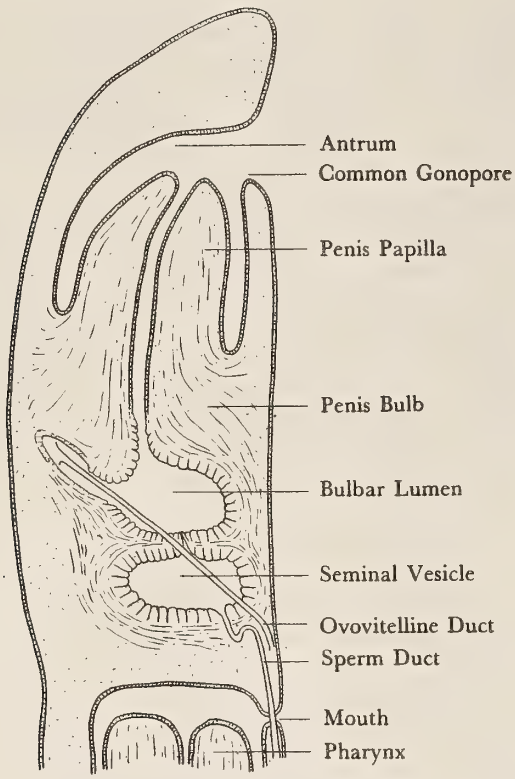

Figure 3: Semidiagrammatic median sagittal section of *Nexilis epichitonius* HOLLEMAN & HAND, gen. et spec. nov. showing the copulatory apparatus.

The triclad was found in association with Mopalia hindsii (Reeve, 1847) and was first observed in the mantle cavity of this chiton. Upon further investigation of the only other chiton in the vicinity, M. muscosa (Gould, 1846), the flatworm was observed to associate only with M. hindsii. At times the flatworm was observed on the dorsal side of the mantle and under the edges of the plates. The worm does not seem to be parasitic on the chiton, but rather exists as a commensal.

The specimens received from Mr. Westervelt were found in a marine aquarium. The material in the aquarium had been collected from the north shore of Smuggler Cove near Short Sand Beach State Park in Tillamook County, Oregon, and no chitons were included. Dr. Eugene Kozloff, Lewis and Clark College, reports the worm to be in association with Mopalia hindsii at Smuggler Cove.

The specimens from Mr. Wright were collected on a dead Cancer productus Randall, 1839, at Sausalito, Marin County, California. The specimens were returned to the laboratory and fixed in Bouin's fixative.

Specimens which were received from Dr. D. Abell were collected from the South Jetty, Coos Bay, Coos County, Oregon, on Thais emarginata (Deshayes, 1839).

The type locality is designated as Stinson Beach, California (122° 37' W.; 37° 53' N.). The holotype (A. M. N. H. No. 503), as a set of sagittal sections, as well as 10 preserved paratype specimens (A. M. N. H. No. 504) have been deposited in the invertebrate section of the American Museum of Natural History.

Acknowledgment

We wish to express our gratitude to Dr. L. H. Hyman for her advice during the course of the work reported here.

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Comparison of Two Similar Species of *Conus* (Gastropoda) from the Gulf of California

Part I: A Statistical Analysis of Some Shell Characters

BY

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(6 Textfigures)

The difficulties experienced by contemporary conchologists in the correct identification of Conus perplexus Sowerby, 1857, are not unprecedented, as Sowerby himself attested when he named this gastropod. In his original description (1857, species no. 157, pl. 14) Sowerby remarked, "This shell perplexes me because there is a variety of Conus puncticulatus which it nearly resembles." The C. puncticulatus of the older writers, however, is definitely not a West American species (Hanna & Strong, 1949, p. 290), while the resemblance which confounds us today is that between C. perplexus and C. ximenes Gray, 1839, both found in the Gulf of California.

Shell pattern and color are so similar in Conus perplexus and C. ximenes as to be virtually identical. To separate the two species, it has been the practice to rely primarily on an apparent difference in size and proportion, and on this basis the smaller, fatter species has been designated C. perplexus, the thinner and longer, C. ximenes. It was my conviction that, if these two "species" are actually distinct, there must be a more objective basis on which to separate them. For instance, I have examined 1'448 cones from the Gulf of California, all of which I am satisfied to assign, on the basis of general shape, shell color and pattern, to this complex. But no feature was acceptable as a basis for deciding to which one of the two species a specimen should be assigned. As will be shown below, neither the literature nor considerations of size range, habitat, and geographical distribution provided such a basis.

Perhaps because an insufficient number of specimens was available to the authors, the literature accessible to me does not contribute to a clarification of the confusion. Sowerby's perplexity was as nothing compared to that of Dall (1910, pp. 219-220). Hanna & Strong (loc. cit., p. 286) have attempted to unravel the synonymy but offer no means of discrimination between the two species.

The size ranges given in the literature are not always applicable. Hill (1959) cites 26 x 16 mm. for Conus perplexus, 40 x 20 mm. for C. ximenes. Keen (1958, #926, p. 482, and #930, p. 483) gives lengths of 30 mm. (C. perplexus) and 42 mm. (C. ximenes). Hanna & Strong (loc. cit., p. 290) report dimensions for only one specimen, a large C. perplexus, of 41.5 x 22 mm. None of these measurements fits the 78 cones which I collected at San Luis Gonzaga on 27 March 1961, the smallest of which was 40 x 25 mm.

Nor would aperture color serve as a basis for separation of the two species. For, although Keen (loc. cit.) mentions difference of color inside the aperture ("blue-violet, deeper within", for Conus perplexus; "purple" for C. ximenes) as a distinguishing characteristic and Hill (loc. cit.) describes both apertures as purple, aperture color in the 1 448 specimens varied from white through pink, blue-violet, and purple.

Geographical distribution of the 1 448 cones studied covers both sides of the Gulf of California, as well as the Pacific coasts of the Mexican mainland, Costa Rica, Nicaragua, and the Canal Zone (see Figure 1). Conus ximenes has been collected at every locality represented, and, although C. perplexus, in the collections I have examined, has not been reported south of Puertecitos on the west coast of the Gulf or south of Mazatlán on the east coast, the area in which these cones coexist is still an extensive one.

As for habitat, the cones which I have collected myself (all on the west coast in the north-

ern part of the Gulf) were found almost entirely on sandbars exposed when the tide was out. In this region the ebbing tide, even when not extremely low, uncovers a series of long, narrow sandbars which, as a rule, parallel the shore. They are separated by shallow, even narrower channels. There appears to be a distinct horizontal zonation of species of some of the common molluscan genera, and it would not seem unreasonable to expect a similar zonation in the distribution of Conus. And yet, I have collected cones on adjacent sandbars during two consecutive low tides which, on the basis of their proportions, should be assigned to the two separate species. Furthermore, two specimens differing enough to make their assignment to a single species questionable were found side by side at Cholla Bay (Gale Sphon, personal communication).

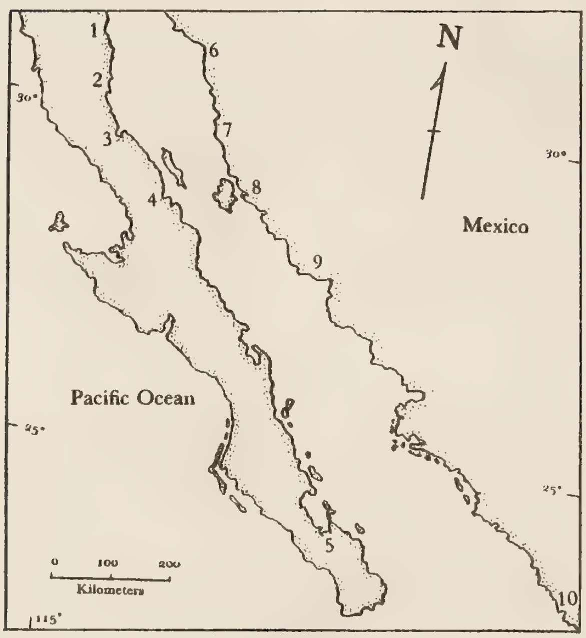

Figure 1: Map showing the collecting stations of the specimens used in this study.

General Areas	*Conus perplexus*	*Conus ximenes*
1 San Felipe	719	20
2 Puertecitos	1	54
3 San Luis Gonzaga		204
4 Bahía Los Angeles		11
5 La Paz		32
6 Puerto Peñasco	150	46
7 Punta Libertad		14
8 Tiburon Island	151	6
9 Guaymas	4	4
10 Mazatlán	17	2
no specific Gulf locality given		13
Total	1042	406

The lack of even one diagnostic feature which I could use as a positive distinction between these two taxa suggested to me the possibility that these cones might actually belong to a single species. This study was undertaken to ascertain by statistical methods whether or not a separation into two groups is valid and, if so, to seek a formula for use in distinguishing between them.

Methods & Procedures

All cones included in this survey were collected in the Gulf of California proper (Figure 1). Specimens from the open oceanic coast of Mexico and its southern neighbors were examined but are excluded from the data presented.

The shells studied are held in the collections of the San Diego Natural History Museum, the Santa Barbara Natural History Museum, and the Department of Zoology of the University of California at Berkeley, and in the private collections of Mr. and Mrs. Emery Chace, Helen DuShane, Faye Howard, Gale Sphon, Kay Webb, and in my own collection. Four hundred six of these specimens were labelled Conus ximenes, and 1'042 were labelled C. perplexus.

Four measurements (length, width, length of bodywhorl, and apical angle) were recorded for these shells (Figure 2). The linear measurements were made to the nearest half millimeter. All measurements were made to the degree of precision possible with the available instruments: lengths and widths by dividers and a millimeter rule; by a machine designed for the San Diego Natural History Museum; or by a very fine calipers. To measure the apical angles, a goniometer was improvised from a carpenter's bevel and a protractor.

It soon became apparent that neither any single measurement nor any pair of measurements could give an accurate picture of the proportions of an individual specimen due to two inconsistent shell characteristics (both extremely common in the shells labelled Conus ximenes and exceedingly rare in those designated C. perplexus). The first consists of damage to the spire, altering its shape. This includes broken or worn primary apical whorls, and the effect on the length measurements and on the apical angle is obvious. The second characteristic is the "dropped shoulder" (Figure 3) which can affect the apical angle measurement by making it impossible to have three points of the spire in contact with the measuring instrument. It also distorts the ratio of

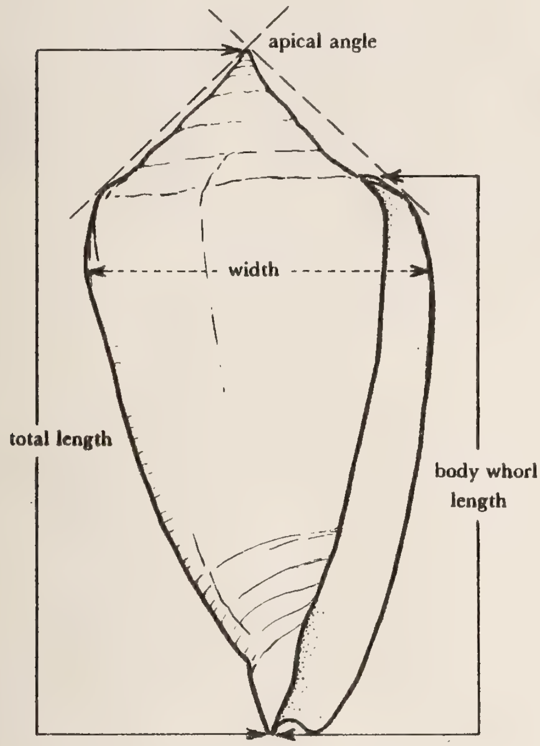

Figure 2: Showing the measurements taken.

bodywhorl length to total length from what might be considered a prototypic proportion. For example, from the data accumulated, one would expect a Conus ximenes with a maximum length of 42 mm. to have a bodywhorl length of about 35 mm. and a spire height of 7 mm., whereas, with a dropped shoulder, the bodywhorl length may be only 32 mm. and the height of the spire 10 mm.

To proceed with the statistical operations, it was necessary to equalize the sample sizes. Four hundred six were selected from the Conus perplexus data by means of a random number table.

As a first step the following calculations were made:

1. The proportion of spire height to total length was expressed as percent by dividing bodywhorl length by total length (= percent ratio).
2. An Obesity Index was determined by dividing length by width and multiplying by 100.

For these two sets of figures and for the apical angle, histograms were plotted for the 812 shells, without regard to division into species. Each histogram showed a bimodal curve, indicating the possibility of two distinct groups. Figure 4 reproduces the histogram for Obesity Index.

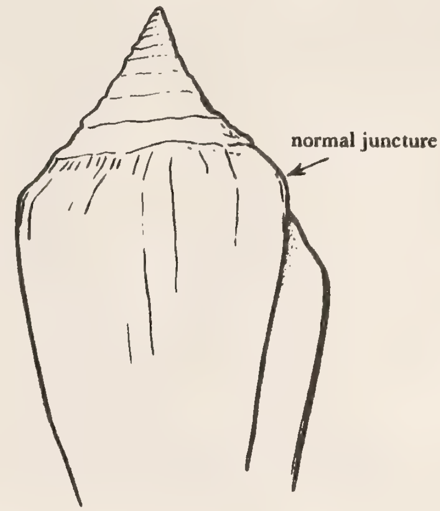

Figure 3: *Conus ximenes* Gray, 1839. Dropped Shoulder. (compare with Figure 2)

Next, histograms were plotted for each set of figures on the basis of the original separation into species made by collector or curator. In each case there was a central overlap that was too extensive to provide any line of demarcation between the two groups, and, for the percent ratio and apical angle, the range of Conus ximenes encompassed that of C. perplexus. As an example, the histogram for Obesity Index is given in Figure 5.

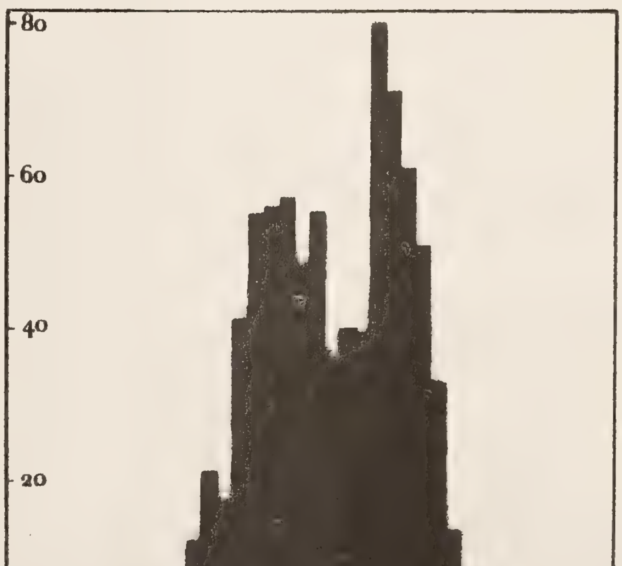

Figure 4: Histogram of Obesity Index of 812 Shells recorded without regard as to species.

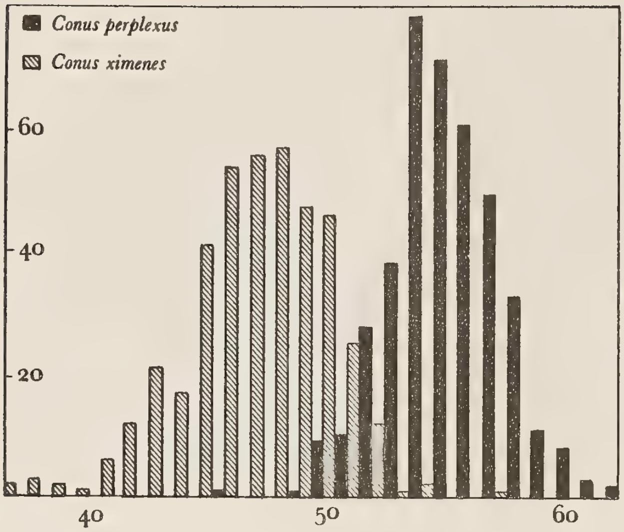

Figure 5: Histogram of Obesity Index of 812 Shells, recorded separately for the two species.

Scatter diagrams were then drawn, correlating each set of figures with length. On the diagrams for the apical angles and for the percent ratio, the overlap remained too great for any separation. The diagram for Obesity Index, however, showed a clearer gap between the two groups. I then prepared a correlation diagram for the 812 shells (406 of each species) based simply upon length and width. This diagram showed practically no overlap, and the two estimated regression lines seemed distinct enough to serve as a basis for further statistical tests.

The length-width measurements were then subjected to multiple regression analysis, with width as the dependent variable, on the CDC 1604 computer of Scripps Institution of Oceanography (Dr. E. W. Fager). The following statistics were obtained.

	Conus ximenes	*Conus perplexus*
Regression Equation	$W = -170.903 + 0.51875\ L$	$W = -61.809 + 0.58126\ L$
Regression significant at:	<0.0001	<0.0001
$\overline{L}$	40.16	22.25
$\overline{W}$	19.12	12.31
% variation in width accounted for by length	98.98	95.32
mean value of discriminant function	7.66	1.32

Since the shells had been divided into the two categories, it was possible to calculate a discriminant function (Mather, 1951, pp. 152-159) from the regression coefficient and the variances obtained in the analysis. This may be approximately expressed by:

Discriminant Function =
$X = \text{Length} - 1.7\,(\text{Width})$

Racial Difference =
$\overline{X}_{\underline{C}.\,\underline{x}.} - \overline{X}_{\underline{C}.\,\underline{p}.} = 7.66 - 1.32 = 6.34$

Discriminant Point =
$\overline{X}_{\underline{C}.\,\underline{p}.} + \frac{1}{2}\text{Racial Difference} = 1.32 + 3.17 = 4.49$

The discriminant function is applied in the following manner: any specimen for which X (length minus 1.7 times width) is greater than the discriminant point (4.49) may be assigned to Conus ximenes; specimens with a value of X below 4.49 are assignable to C. perplexus.

The probability of misclassification is given by the P associated with t (809 df) = 2.046 (p = less than 0.025). The discriminant function is therefore a very good basis for classification.

Results

Both sets of cones mentioned above (those taken on adjacent sandbars and the two that were found side by side) prove, by the application of this function, to have been correctly assigned to the two separate groups.

In addition to the statistical information, examination of these 1 448 cones has revealed one shell characteristic that is almost foolproof for the visual separation of Conus perplexus and C. ximenes, i. e., the configuration of the posterior notch at the top of the bodywhorl as it diverges from the spire to form the outer lip. It is easily recognizable when looking directly down at the spire (Figure 6a) or straight at the lip edge of the bodywhorl (Figure 6b).

In Conus perplexus the line formed by the notch is recurved (Figures 6a, 6b). In C. ximenes, in contrast, the line is practically straight and usually oblique (Figures 6c, 6d). Although here, too, C. ximenes is exceedingly variable, careful inspection should eliminate confusion between its random curvature and the definite arcs of the notch in C. perplexus. I believe that departure from a straight, oblique line in C. ximenes is a deviation from the norm as, in the 406 specimens examined, it was accompanied by evidence of aberration or injury in every case.

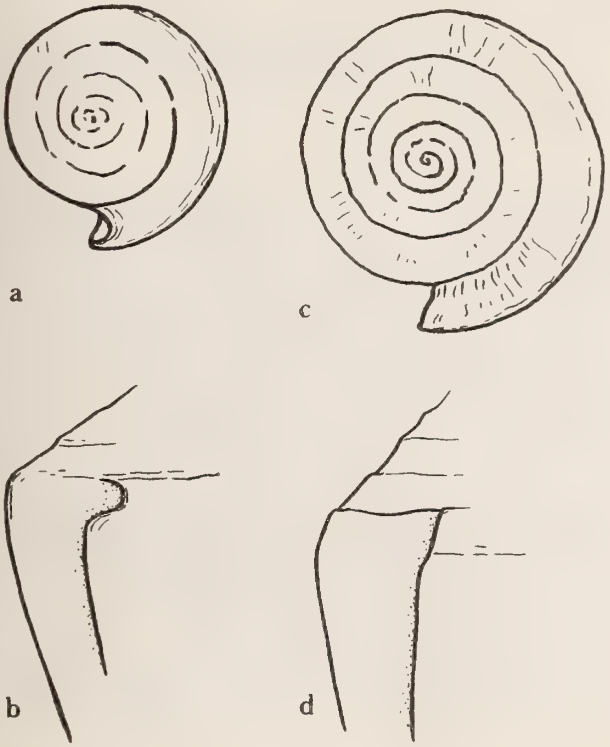

Figure 6: Illustrating Shell Differences for the two species, *Conus perplexus* SOWERBY, 1875 and *C. ximenes* GRAY, 1839.

a: apical view, b: lip of *Conus perplexus*; c: apical view, d: lip of *Conus ximenes*.

Discussion

Two other taxonomic questions have arisen from examination of these collections. One is the need for investigation of the validity for the Gulf of California of the taxon Conus mahogani (considered by some authors a race or variety or subspecies, C. ximenes mahogani Reeve, 1843). Shells which were labelled C. mahogani are not included in this survey, although most of them vary only slightly, if at all, in either appearance or measurements from C. ximenes. It is possible that they have been misidentified and should be reclassified as C. ximenes.

At the same time there are a few specimens from Panama, labelled Conus mahogani, which are entirely different in shape and proportion, color and pattern, from any of the Gulf specimens so identified. Therefore, I suggest that this taxon needs revision. However, this problem is beyond the scope of my studies.

In scrutinizing these collections it has become apparent that there may be still a third species in this complex. About a dozen specimens, labelled Conus perplexus in some collections and C. ximenes in others but differing from C. perplexus and C. ximenes at least as much as those two differ from each other, have come to light. A re-examination of these specimens and a search for more are indicated.

Handling, hunting, observing, and examining so large a number of specimens could hardly fail to raise many questions unrelated to the taxonomic issue. For instance, it is interesting to conjecture why Conus ximenes is so subject to aberrations in spire shape. Does this result from damage occurring when the outer lip of the shell is being laid down and is very thin? Of what significance is the fact that, with the exception of the large sampling from Kino Bay, which contains many atypical specimens, there is rarely any deviation from the normal spire shape in C. perplexus? Might these phenomena indicate a difference in the manner or rate of growth of these species? I intend to continue observing these animals in the field and in the aquarium.

Both species show a surprisingly small size range in the samplings I have collected in 1961 and 1962. There is no continuous distribution in length, and juveniles are extremely difficult to find. While the data which I am accumulating may not solve these puzzles, they do suggest the possibility of a measure of growth rate.

I also hope to begin a study of the radulae and anatomy of these cones.

Acknowledgment

I wish to express my grateful appreciation to Dr. Eric G. Barham and Dr. David Shepard of San Diego State College for the time and the guidance they have given me; to Drs. E. W. Fager and John MacGowan of Scripps Institution of Oceanography for advice and encouragement; to the museums and individuals who have made specimens available to me; to Mr. Emery Chace for aid with the literature; and to Alan, Lori, and Arthur Wolfson for assistance in collecting specimens.

Summary

The statistical tests reported here have supplied a means of distinguishing between Conus perplexus Sowerby, 1857, and C. ximenes Gray, 1839, that is reliable 97.5 times out of 100. A visual diagnostic feature has also been described. This study has demonstrated statistically what conchologists have always in-

stinctively felt: that there actually are two populations of cones living side by side in the Gulf of California which, in spite of extremely nonspecific characters and habitat, comprise two objectively definable groups.

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A New Land Snail from the Klamath Mountains, California (Mollusca : Pulmonata : Polygyridae)

BY

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Willow Creek, California

(Plate 5)

In the fall of 1956, I discovered accidentally an unusual land snail belonging to the genus Vespericola. Because of winter storms and high water, no additional specimens were found until late summer of 1957. In subsequent summers more specimens of this uncommon snail were collected, and more detailed information on its range and ecology was added. Unfortunately, all of this was lost in a fire in 1960. Further collecting since has replaced the loss, and at the present time there are enough specimens on hand for a critical review. A detailed study indicates the advisability of describing this rare snail as a new species.

Vespericola karokorum Talmadge, spec. nov.

Description of Holotype

An adult specimen with shell of fairly large size for the genus, low-spired, imperforate except for a small umbilical chink, with a moderately reflected lip and a well developed crescentic, slightly arcuate parietal tooth. The pale brown or tan colored periostracum is thin and exhibits a matte surface which, under magnification of x20, consists of extremely fine transverse wrinkles, in some places broken up into minute granules. Major characteristic ornamentation is the prominent, evenly and widely spaced, scimitar-shaped, fine pointed periostracal hairs, apparently not arranged in any definite geometric order and having their bases flattened in the direction of growth of the shell. Base of lip imperceptibly notched and slightly flared over the umbilical region, leaving a tiny umbilical pit not visible from a direct basal view. Total whorls nearly 6, well rounded, with a well impressed suture. The reflected lip is pale brown and has a form similar to other species in the genus. Maximum diameter, 16.2; minimum diameter, 13.6; height, 8.9 mm.

Explanation of Plate 5

Holotype of *Vespericola karokorum* Talmadge, spec. nov.
Figure 1. Dorsal aspect. Figure 2. Ventral aspect. Figure 3. Lateral aspect.

Figure 1

Figure 2

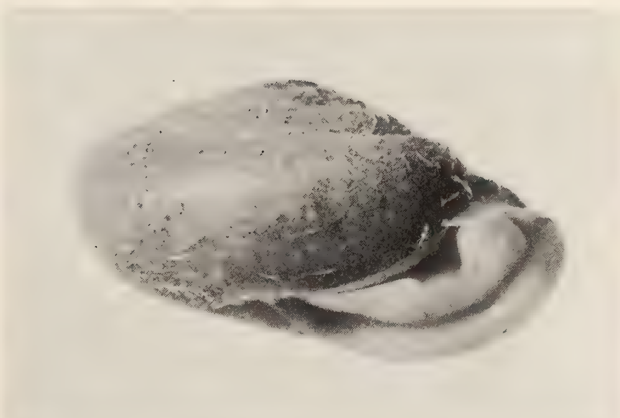

Figure 3

G Dallas Hanna, *photo.*

Type Locality

Sawmill Gulch, a narrow fissure on the north side of the Klamath River, on the Ishi Pishi Road, 2.0 miles east of the Orleans Ranger Station, Humboldt County, California. Collected by R. R. Talmadge, July 1961. Other localities include similar fissures on the Ishi Pishi Road from a point 1.5 to 2.5 miles east of Orleans, Humboldt County, California.

Distribution of Specimens

Holotype in the California Academy of Sciences, Paleontology Type Collection No. 12 380. Three paratypes in the same collection, Nos. 12 381, 12 382, and 12 383. Other paratypes to be deposited in the type collections of the United States National Museum, the Academy of Natural Sciences of Philadelphia, the Museum of Comparative Zoology (Cambridge), the Chicago Natural History Museum, the San Diego Society of Natural History, Stanford University, and various private collections.

The name is derived from the local tribe of Indians inhabiting the central Klamath River area: Karok.

Comments

It is astonishing to find a new and well defined species of the genus Vespericola in an area hitherto considered to be the particular province of species with densely set, short-haired periostracum represented by V. megasoma (Dall in Pilsbry), V. megasoma euthales (Berry), and the smaller V. eritrichius (Berry). Vespericola karokorum is easily separable from each of these because of the prominent, long, curved, sparsely set hairs, strong parietal tooth, depressed form, and lack of an open umbilicus. One might expect it to be more nearly related to the wide ranging V. columbiana pilosa (Henderson) (Alaska to Central California), but this is invariably narrowly umbilicate, higher spired, more densely pilose with shorter hairs, and with considerable variability in the presence or absence of a parietal tooth and in its strength when present. The new species has the depressed form of the little known V. columbiana depressa (Pilsbry & Henderson) from the Dalles, Oregon, but this is a toothless form covered with rather densely set short hairs. Vespericola pinicola (Berry) from Monterey County, California, is another more hairy, toothless species with a higher spire. Vespericola karokorum is more like V. amigera (Ancey) from the Santa Cruz Mountains of California in general aspects, including size, but the latter has a densely pilose periostracum that is totally different. Besides, these two central California species are far removed in range, and no intergrades with the northern California species are known to exist. Adult specimens of V. karokorum are constant in primary characteristics and exhibit little in the way of individual variations.

The ecological niche of Vespericola karokorum is notable. In the Klamath Mountains of northern California other Vespericola species may usually be found in the moist shaded areas in the smaller "V" canyons of tributary streams. They prefer the mossy rocks and the cover offered by accumulated debris along the canyon bottoms, but on occasions they are found in exposed locations under damp logs. In contrast, V. karokorum seems to prefer only the deepest, narrowest, fissure-like gorges, never exposed habitats; they are always found extremely close to water, often so close that the apex of the shell is wet as they cling to the underside of clean-washed rocks. They seem never to come out into the open, even on rainy or cloudy days, possible evidence that the species is entirely nocturnal. This remains to be verified, but hunting by night in the areas where these snails live is liable to be hazardous.

So far, specimens have been found along what may be termed the "outside or current" side of a major bend in the Klamath River. The fissures and deep narrow canyons bordering the river are separated both upstream and down by steep slopes or cliffs of schist that become extremely dry in summer. Any snails washed into the river from small tributary streams during heavy run-off would be tossed back onto the same side of the river within a short distance. Thus, the probabilities of finding ecologically suitable niches where they would be likely to survive are slim indeed, and this situation may effectively limit the distribution of the species by means of this fairly common method of dispersion.

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Studies on *Erosaria lamarckii* Gray (Gastropoda)

BY

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University of Halle (Saale), Germany

and

RONALD STEWART BENTON

Mombasa, Kenya

(Mr. Benton collected all Erosaria lamarckii from Port Reitz, described the locality and forwarded the statistical data of 179 specimens to the Schilders who added the data of another 105 specimens from Port Reitz and of 269 from other localities, and investigated the results statistically.)

There are two geographical races of Erosaria lamarckii Gray: the Indian E. l. redimita Melvill (abbreviated "I" in this paper) from Penang to Karachi, the Seychelles, and Mauritius, and E. l. lamarckii s. str. (abbreviated "A") from Natal to Ras Ngomeni in Kenya; in Madagascar both races seem to occur (see Schilder, 1938). Recently, we have examined a large population living at Port Reitz near Mombasa, Kenya, which seems to be intermediate in some respects (abbreviated "R").

Port Reitz is named after Lieutenant Reitz of the Royal Navy who died in Mombasa as commandant of the island in 1825. It is merely an extension of Mombasa's main harbour, Kilindini, and is used as an anchorage for ocean-going vessels. The Erosaria lamarckii lamarckii have been found in two restricted areas on the shores of Port Reitz, namely, at an unnamed place on the north shore and at Ras Kigangone, or Flora Point, on the south shore. The rise and fall of the tide in these waters attains a maximum of 13 feet, and all cowries have only been found at very low spring tides. The water has always been very dirty and opaque.

On the north shore at low tide the sand of the beach gives way to thick black mud interspersed here and there with areas of mud-covered rock on which are found broken fragments of rock and weeds. It is in these areas that hundreds of Erosaria lamarckii lamarckii were found, usually partially hidden but always to some extent exposed to the unnatural elements of sun, rain, and wind. In the same place another cowrie, Monetaria moneta (Linnaeus, 1758), was very abundant, and E. erosa (Linnaeus, 1758), E. helvola (Linnaeus, 1758), and Erronea caurica (Linnaeus, 1758) were common, but Palmadusta diluculum (Reeve, 1845) [and one specimen of P. ziczac (Linnaeus, 1758)] were rare.

The conditions at Flora Point on the southern shore appear to be the same as on the northern, but here Adusta onyx (Linnaeus, 1758) predominated over Erosaria l. lamarckii; Erronea caurica was quite common; and Erosaria erosa occurred occasionally; but no Monetaria moneta nor Palmadusta diluculum were found. No explanation can be given for the complete absence of M. moneta nor for the apparent transposition of the relative frequencies of E. l. lamarckii and A. onyx between the two localities which are less than a mile apart. The collecting ground on the south shore is closer to the actual harbour at Kilindini and therefore receives more refuse from the ships. Deepwater berths have recently been constructed and opened to shipping, and one could be inclined to the belief that pollution of the water may be responsible for the present absence of cowries, which is hoped to be temporary only. Besides, the disturbance of the creek-bed by dredging has caused the collecting areas to be coated with a blanket of weed not hitherto seen.

The following characters of shells have been investigated in this study:

L = the length of the shell, measured in tenths of a millimeter, reduced to mm., and tabled in classes the indicated means of which differ by 3 mm. (e.g., 18 = 16.5 to 19.5 mm.).

BL = the maximum breadth, expressed in percent of the length.

DL, DC = the closeness of the labial and

columellar teeth respectively, expressed by letters (earlier letters of the alphabet indicate less numerous teeth than later letters; see Schilder, 1958).

DF = the number of real denticles on the inner border of the fossula.

Co = the color of the dorsum expressed by two letters, the first of which indicates the prevalent shade. As in previous papers, we have distinguished: a = white; b = brown; f = fulvous; g = grey; l = orange; n = black; v = green (see Schilder, 1952). In summarizing, the prevalent color has been considered of double the value of the accessory shade.

Oc = the development of lilac grey ocelli within the white dorsal spots (the lateral ones excluded), expressed by the letters: i = absent; v = pale or scarce; and n = well developed (see Schilder, 1952).

In the tables the sign "0" indicates rare frequency in less than 0.5 percent, whereas the sign "-" indicates total absence.

LENGTH

The following table illustrates the variation in size, expressed in classes of 3 mm. (see above); the figures indicate percent of 143 I (including the data published in the diagram by Griffiths, 1956), 284 R, and 126 A.

	18	21	24	27	30	33	36	39	42	45	48	51
I	1	1	10	21	27	21	10	7	2	-	-	-
R	-	0	4	11	36	27	14	6	1	0	-	-
A	-	-	-	1	5	14	24	18	20	13	4	1

The exact means are: I = 30.6; R = 31.9; and A = 38.6 mm. The difference between I and A is mathematically significant, but R is similar to I instead of to A as one would expect on the basis of geographical reasons. The median length in large areas is as follows:

No.	I	mm.	No.	A	mm.
66	Penang (Griffiths)	29	16	Natal	39
			23	Mozambique	37
25	Mergui — Bombay	34	46	No locality	40
			30	Zanzibar, etc.	39
19	No locality	30			
28	Karachi	31	11	Madagascar	35
5	Lemuria	30			

The 28 I shells from Karachi were erroneously credited to Aden by Schlesch (see Schilder, 1931).

The medians of I (29 to 34) distinctly differ from those of A (37 to 40), the dwarf A of Madagascar excluded.

BREADTH

The relative breadth varies considerably. The mean and the range (in brackets) of 90 percent of the least unusual shells (see Schilder, 1961) are as follows:

I = 65.9 (60-71)
R = 67.6 (62-73)
A = 64.4 (59-70)

Therefore, the average shells of R seem to be broader than both I and A. But there is a distinct correlation between length and relative breadth, as larger shells usually are more slender than small shells, so that the mean index BL of shells of 25 30 35 40 mm.

	25	30	35	40
is, in I:	70	66	63	59
in R:	73	69	65	62
in A:	-	72	68	64.

These rough figures prove R to be intermediate between I and A with regard to its relative breadth.

DENTITION

There is no difference between I and A with regard to the closeness of the teeth on both lips, and R also agrees with both. The median of labial:columellar teeth is in each group l:k, the range of 90 percent of 441 shells is (i-n):(h-m).

FOSSULA

The number of the fossular denticles varies from 1 to 5; the average number and the range (in brackets) of 90 percent of the shells are as follows:

I = 2.0 (1-3)
R = 2.1 (1-3)
A = 2.8 (2-5)

But as larger shells show, on an average, more denticles than smaller shells of the same race, these figures exaggerate the larger figure in A: according to the regression line one must expect in A of a length comparable to I and R (32 mm.) at most 2.5 fossular denticles, so that the general increase from I over R to A becomes less distinct.

COLOR

The occurrence of the various shades explained above is as follows (expressed in per-

cent of 69 I, 272 R, and 78 A):

	a	v	f	l	b	s	g	n
I	0	14	64	2	14	5	0	-
R	0	8	24	1	57	7	2	0
A	0	8	23	1	56	6	5	1

There is a striking similarity of R to A, whereas I is quite different: the paler shades (f, v, a) amount to less than one-third only in A and R, but to more than three-quarters in I.

OCELLATION

The distribution of the three varieties in dorsal markings, called i:v:n, has been expressed in percent of 69 I, 272 R, and 78 A, as follows:

I = 94:4:2
R = 32:28:40
A = 5:23:72

Therefore, I and A are contrary, and R evidently is intermediate between the white spotted I and the ocellated A.

Summary

There is a distinct statistical difference between the eastern Erosaria l. redimita (I) and the western E. l. lamarckii (A) concerning the length of the shells, the general color of their dorsum, and the ocellation of the white dorsal spots; the differences in the relative breadth and in the denticulation of the fossula are less obvious, and in the closeness of the teeth along the aperture there is no difference at all.

The population living in an isolated area at Port Reitz near Mombasa, i. e., on the northern limit of the East African Erosaria l. lamarckii, agrees with the latter in the brown dorsal color only; its size and fossula rather agree with E. l. redimita, which spreads from Malacca to the Seychelles not too far from the Kenya coast, so that one could suspect genetical influence; the breadth and the dorsal markings are intermediate. Therefore, the population of Port Reitz is exactly intermediate between the widely distributed Indian and African races, both geographically and morphologically.

The few shells coming from Madagascar seem to connect the two races in another way.

APPENDIX

Among 75 specimens from Port Reitz which were examined also anatomically, there were 34 females and 41 males (sex ratio: females = 45 percent). The average length of the shells, the animal of which could be examined, is 32.68 mm. in females and 31.95 mm. in males; the relative breadth is 68.47 and 67.46, respectively. Therefore, the females seem to be slightly larger and broader (especially in view of the fact that larger shells generally are more slender); but the difference is by no means significant mathematically. In the other characters there is evidently no sexual difference at all. The radula will be discussed in another paper.

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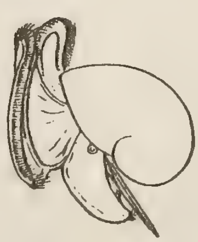


A New *Stiliger* and a New *Corambella* (Mollusca : Opisthobranchia) from the Northwestern Pacific

BY

JAMES R. LANCE

Scripps Institution of Oceanography, University of California, La Jolla, California

(Plate 6; 10 Textfigures)

The opisthobranch fauna of the Pacific Coast of North America includes a large number of species readily identified in the living state by their diversity of external morphological features and spectacular coloration. On the other hand, a not insignificant number of new species has been collected from this area, species which are so inconspicuous as to be only accidentally detected. While some of these unobtrusive forms are rare, or at best occur sporadically in conservative numbers, a few others form enormous annual populations in their respective habitats.

The present paper is a result of investigations carried out on two new, inconspicuous species which are both extremely abundant, confined to entirely different habitats, and both represent genera new to the northwestern Pacific Coast.

I am very grateful to the Scripps Institution of Oceanography, Marine Life Research Program, for providing funds for the color plate, and to Dr. and Mrs. G Dallas Hanna of the California Academy of Sciences for its expert execution. It should be noted that both animals have been photographed non in situ in order to provide contrasting background.

SACOGLOSSA

Elysiacea

Hermaeidae

Stiliger fuscovittata Lance, spec. nov.

(Plate 6, Upper Figure; Textfigures 1 to 5)

Many individuals of this species have been collected during every season over a period of several years. During the autumn and winter months they are rare; in the spring and summer large numbers may be found in the appropriate biotope.

The largest individual measured was 10.2 mm. long and 1.1 mm. broad; the smallest specimen measured 1.7 mm. long and 0.2 mm. broad. The average size of sexually mature individuals at the height of the spawning season is 7.6 mm. in length and 0.85 mm. in width. The holotype, upon which this description is based, was 8.0 mm. long and 0.9 mm. broad. All measurements given are for actively crawling animals.

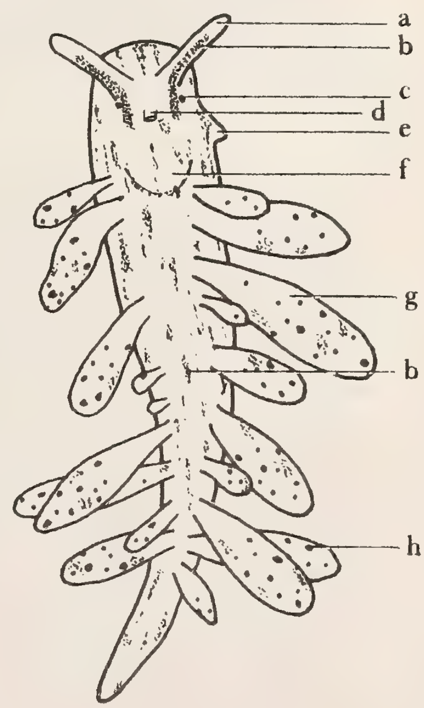


Figure 1: *Stiliger fuscovittata* Lance, spec. nov.

Dorsal view of living animal

a. rhinophore
b. pigmented area
c. eye spot
d. anus
e. genital papilla
f. pericardial prominence
g. ceras
h. cutaneous gland

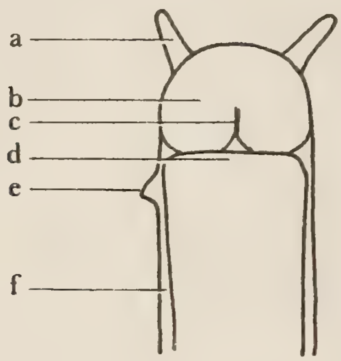


Figure 2: *Stiliger fuscovittata* LANCE, spec. nov.
Antero-ventral view of living animal
a. rhinophore
b. oral lobe
c. mouth
d. anterior foot margin
e. genital papilla
f. side of body

The body in general shape is eolidiform, broadest in front, and tapering to an elongated, bluntly rounded tail (Textfig. 1). In some individuals the tail may appear considerably shorter due to the presence of a few small cerata occurring almost to the tip. The back is rounded, not at all marked off from the vertical sides of the body.

At its anterior margin, the foot is as broad as the body, becoming progressively narrowed posteriorly. There are neither foot tentacles nor a median notch (Textfig. 2). In its ventral aspect, the head consists of two large, inconspicuous lobes with the mouth appearing in the middle as a longitudinal slit.

The cerata are arranged in two single series along either side of the back near its lateral edges. They arise at the antero-lateral margins of the pericardial prominence and run posteriorly, alternating or not. Considerable variation in size, shape and number occurs between one individual and another. Although detailed observations on large numbers of specimens have been made, the irregular alternation of the highly deciduous cerata is without pattern and is undoubtedly a result of varying stages of ceratal regeneration. The holotype, which represents the typical condition, has nine in the left row and ten in the right. The liver is brown, slender, rope-like and runs under the right and left rows of cerata. Each ceras receives a conspicuous unbranched diverticulum not quite reaching the tip. Several large cutaneous glands occur most abundantly in the middle and distal portions of most cerata, and appear as conspicuous white spots. Similar but smaller glands are abundant on the anterior portion of the sides of the body.

The rhinophores are non-retractile, smooth and taper to blunt tips. They are neither auriculate nor flattened. Each arises about half way up the sloping antero-lateral end of the body and points obliquely forward in life.

The conspicuous black eye spots are present immediately behind the rhinophores in regions free of epidermal pigment. In some individuals the eye spots border pigmented areas, but in no instance do they occur beneath such areas. The anus is located on a slightly elevated papilla on the mid-dorsal line immediately posterior to the eye spots. This position is considerably more anterior than that reported for other members of the genus. The genital papilla is prominent in living individuals and occurs slightly posterior to the anus about half way up the right side of the body. In life, the aperture faces somewhat posteriorly.

The radula consists of seven teeth in the ascending, 23 in the descending limb and about four undifferentiated elements in the spiral ascus (Textfig. 3). Little variation in teeth number in several individuals examined was observed. The figured radula is from a paratype of equal size in order to retain the holotype intact.

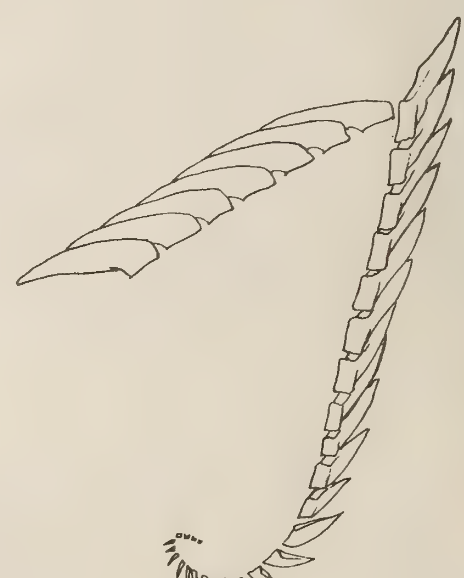
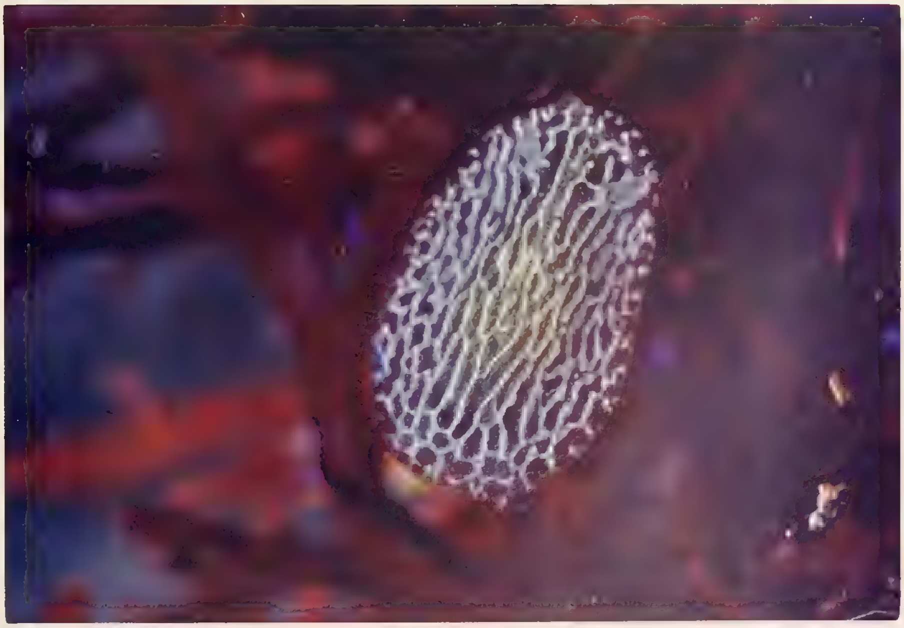


Figure 3: *Stiliger fuscovittata* LANCE, spec. nov.
Radula, x 128

Stiliger fuscovittata LANCE, spec. nov.



Corambella steinbergae LANCE, spec. nov.

Kodachromes by JAMES R. LANCE

The body is nearly transparent and many of the internal organs may easily be observed without clearing. The reddish-brown pigmentation varies between individuals in intensity, amount and pattern but not in basic color. The most constant feature of the pattern is two stripes, each of which arises about one third of the distance from the distal end of the rhinophore, runs to its base, and proceeds posteriorly on the back for a short distance, flanking the eye spot. Numerous streaks and splotches occur over the rest of the body (except on the foot sole which is colorless), and to a lesser degree on the cerata. As mentioned above, the cutaneous glands of the cerata form conspicuous white spots. Microscopic examination of the epidermis in the pigmented region reveals that the pigment flecks are gathered into a mosaic-like pattern (Textfig. 4). A dingy pale yellow color often occurs on the tip of the tail, distal portion of the rhinophores, and median region of the mouth lobes.

This species has been collected only in San Diego and Mission Bays, where it feeds exclusively on the red alga Polysiphonia pacifica Hollenberg (1942)(identified by Mr. David Chapman of the Scripps Institution of Oceanography), which is common on pilings and boat landings. Gonor (1961, pp. 86 and 95) has summarized the observations of several authors concerning the specificity of different species of Sacoglossa to one or a few closely related species of algae. Thus it is not surprising to find the present Stiliger occurring exclusively on P. pacifica.

The egg capsules are thick, sausage shaped, exhibit considerable variation in length and amount of spiraling, and layed among the algal mass (Textfig. 5). The height of spawning is reached during May to July.

The specific name fuscovittata was chosen to call attention to the brownish streakings which constitutes the principal coloration of this species.

Figure 4: *Stiliger fuscovittata* LANCE, spec. nov. Detail of pattern in pigmented area, x 212

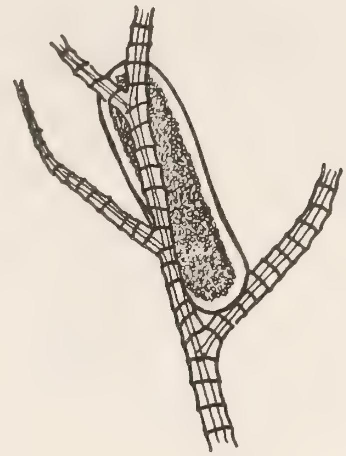


Figure 5: *Stiliger fuscovittata* LANCE, spec. nov. Egg capsule in situ

Type locality: Mission Bay, San Diego, California; on Polysiphonia pacifica Hollenberg, 1942. Lat. 32° 42' N., Long. 117° 11' W.

The holotype is deposited at the California Academy of Sciences, where it is registered as Paleo. Type Coll. No. 12 403; it will be incorporated into the Frank Mace MacFarland Memorial Collection of Nudibranchs.

NUDIBRANCHIA

Doridacea

EUDORIDACEA

Phanerobranchia

SUCTORIA

CORAMBIDAE

Corambella steinbergae LANCE, spec. nov.

(Plate 6, Lower Figure; Textfigures 6 to 10)

Synonymy:

Corambella spec., STEINBERG, 1960;
Corambella spec., LANCE, 1961.

Numerically, this kelp-inhabiting species is one of the most abundant nudibranchs along the coast of southern California, and, if local population size is typical, it must occur in enormous numbers throughout its entire range. Sixty-eight individuals have been counted from a single kelp frond during the height of its spawning season.

The largest individual measured was 8.2 mm. long and 5.1 mm. wide. During the spawning season minute individuals measuring only 0.12 mm. in length are commonly observed

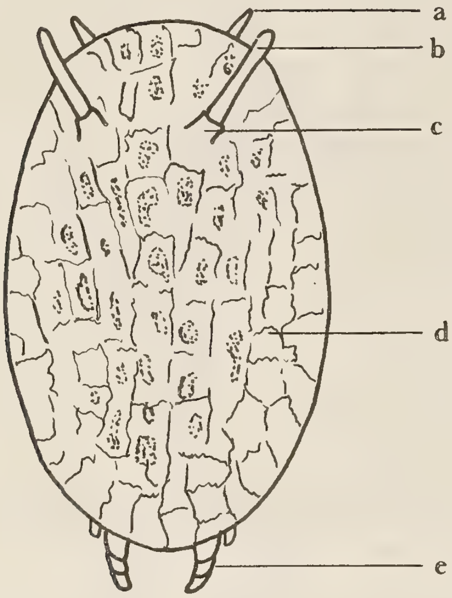


Figure 6: *Corambella steinbergae* Lance, spec. nov.
Dorsal view of living animal
a. oral tentacle
b. rhinophore
c. rhinophore sheath
d. notum
e. posterior gill

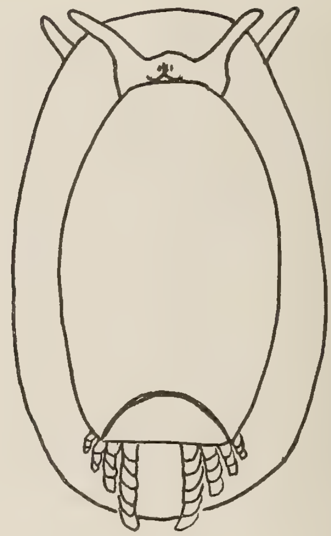


Figure 7: *Corambella steinbergae* Lance, spec. nov.
Ventral view of living animal

when small pieces of kelp are examined under a dissecting microscope. These small specimens represent that portion of the population which has only recently metamorphosed. When crawling, the holotype was 5.3 mm. long and 3.2 mm. wide, which is average for a sexually mature individual.

The general body form is oval, disc shaped and flattened when the animal is stationary, but somewhat more elongate and broader behind than in front when moving (Textfig. 6). The notum is broad, only slightly arched in the middle of the body, and flat and thin where it projects well beyond the foot margins. As in other members of the genus, its border is entire, not notched. A deciduous cuticle, similar to that described for other Corambidae occurs as the outer notal layer (see p. 9 in MacFarland and O'Donoghue, A new species of Corambe from the Pacific Coast of North America. Proc. Cal. Acad. Sci. ser. 4, 18(1): 1-27, 1929). The heart is located about two thirds of the way back on the midline of the body.

The foot is oval, rounded posteriorly, never extending beyond the lateral notal margins, and in some individuals is entire along the anterior edge (Textfig. 7). In other specimens an emargination is present, but never so pronounced as in Corambe pacifica MacFarland & O'Donoghue, 1929. The presence or absence of a foot notch cannot be a specific characteristic since it occurs in varying degree.

The branchiae are posterior, attached to the underside of the notum at the juncture between the notum and the foot; they number 3 to 6 on either side of the median line in typical individuals. The two large posterior gills and the

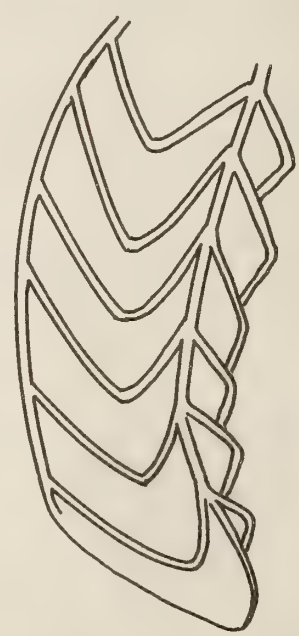


Figure 8: *Corambella steinbergae* Lance, spec. nov.
Detail of large gill

oral tentacles project beyond the notal margin when the animal is crawling. The anus lies between the two most posterior large gills. The remainder progressively decrease in size outward. Each of the largest gills consists of a flattened, horizontally-oriented central element which gives rise to about 6 vertically directed secondary lamellae on either side (Textfig. 8). The smaller gills have fewer secondary lamellae.

The retractile rhinophores are 1.2 mm. in length, smooth, and taper to a blunt point distally. The sheaths have a smooth margin and are about one quarter the length of the rhinophore.

The penis is located about a third of the way back on the right side of the body. When fully extended in a living individual it is long, possesses a distal sharp constriction followed by a flared portion and has a flat, not tapering tip (Textfig. 9). These features are not evident in preserved specimens.

The radula has the formula:
41-52 x 5.1.0.1.5 (Textfig. 10).

The first lateral is the largest and bears 5 to 7 small denticles on its inner side. The following 4 laterals decrease in size outward and are devoid of denticles.

The color and pattern very closely resemble Corambe pacifica and consist of a nearly transparent body overlaid with a reticulation of opaque white lines very closely approximating the ectocysts of the bryozoan colonies upon which it is found. Occurring within the boundaries of many of the cells formed by the white lines are irregular splotches of rust-red with darker margins. The soft parts of each bryozoan zooid also possess a central spot of similar color. Thus the nudibranch is almost indistinguishable from its background.

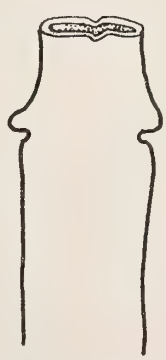


Figure 9: *Corambella steinbergae* LANCE, spec. nov.
Penis

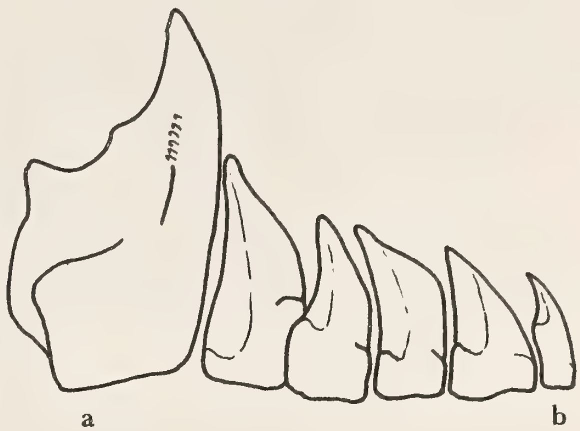


Figure 10: *Corambella steinbergae* LANCE, spec. nov.
Radula
a. first lateral tooth
b. outermost lateral tooth

Type locality: Offshore kelp canopies, San Diego, California. Lat. 32°40' N, Long. 117° 14' W.

The species name steinbergae was chosen to honor Miss Joan E. Steinberg who first noticed the specific characters separating it from Corambe pacifica, and who has made valuable contributions to our knowledge of opisthobranchs from the Pacific.

The holotype is registered as Paleo. Type Coll. No. 12'404 at the California Academy of Sciences. It will be incorporated into the Frank Mace MacFarland Memorial Collection of Nudibranchs.

Remarks: The genera Corambe and Corambella are currently separated by the presence of a posterior notal notch in the former, while the margin is entire in the latter. This single characteristic clearly separates the two sympatric Pacific Coast genera. In addition, the present species is easily distinguished from Corambe pacifica by its long, smooth rhinophores, possession of few gills, and well developed head with long oral tentacles extending beyond the notal margin. It differs from all other described species of Corambella by its long, smooth rhinophores. The branchial structure of the present species, however, shows closer affinity to Corambe pacifica than to the other 3 known species of the genus. Corambella baratariae Harry (1953), C. depressa Balch (1899), and C. carambola Marcus (1955) all have simple, overlapping, plate-like gill lamellae.

The following species have been assigned to Corambella:

1. Corambella depressa Balch, 1899
   Cold Spring Harbor, Long Island, New York. Under stones on which Fucus was growing.

2. Corambella barataride Harry, 1953
   Barataria Bay, Grande Isle, Louisiana. On oyster beds (Crassostrea virginica) at depths of about five feet.

3. Corambella carambola Marcus, 1955
   Island of São Sebastão, State of São Paulo, Brasil. On bryozoa growing on algae (Padina) on stones in the upper littoral zone.

4. Corambella steinbergae Lance, spec. nov.
   Point Eugenia, Baja California, Mexico, to Vancouver Island, British Columbia. On offshore kelp fronds where it feeds on bryozoa (Membranipora serrilamella).

The systematic position of the following species is uncertain, but it seems likely that subsequent examination will establish their affinity with Corambella as it is currently defined:

1. Doridella obscura Verrill, 1873
   Long Island Sound, New York, to Great Egg Harbor, New Jersey. At low water, under stones, and to 4 to 5 fathoms.

2. Corambe batava Kerbert, 1873
   Netherlands.

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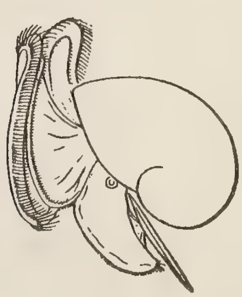

A Checklist of Mollusks for Puertecitos, Baja California, Mexico

BY

HELEN DUSHANE

Conchological Club of Southern California, Los Angeles 7, California

(1 Textfigure)

Introduction

Puertecitos on the west shore of the Gulf of California is 180 miles south of the International Boundary, at Latitude 30° 25' N., Longitude 114° 39' W. It nestles between low, rocky promontories, and at each low tide the great rush of tidal bore drains away some 18 to 20 feet of water, leaving a rocky rubble area at one's feet and, beyond that, a muddy sand flat broken by runnels and drainage channels. The variety of molluscan life here includes Tagelus, Dosinia, Chione, plus Terebra and Oliva. On the coralline shelf are Trigonostoma and Strombina, while Mitra, Anachis, and various amphineurans hide under the boulders. The outer strand, at extreme low tide, offers such rarities as Terebra bridgesi and Clavus ianthe, while the rubble at the foot of the promontories shields Cypraea annettae, Trivia solandri, Lima orbignyi, and L. pacifica.

This paper is intended to supply collectors with a working list and does not presume to be all-inclusive. The specimens include those taken by active collectors in an area of about five miles north to about five miles south of the tiny settlement of Puertecitos.

Systematic Account

In this list the following format is adopted:

1. The species number given by Keen (1958) and the scientific name.
2. An asterisk (*) preceding the Keen number indicates range extension.
3. Relative abundance or rarity; a number in parentheses indicates the number of persons known by me to have taken this species at Puertecitos.
4. The habitat of the specimen such as "sand beach, low tide" or "intertidally, under rocks".
5. Range extensions are noted, giving the most northerly previously recorded place of occurrence. It must be remembered that the northern limits for a species given in Keen (1958) are generalized and based upon admittedly incomplete lists. An attempt is made here to point out any extension of range from that reported in Keen's work.
6. The following individuals have made their collections available and are designated in the working list by initials:

Dr. Bruce Campbell	Ca
Emery Chace	Ch
Eugene Coan	Co
Joseph and Helen DuShane	D
Faye Howard	H
Dr. Homer King	K
Dr. Donald Shasky	Sh
Gale Sphon	Sp

Ecological Notes on Eighteen Collecting Areas

as numbered on map (figure 1)

1. Shore is rocky with turnable-sized rocks that reveal Trivia solandri, Cypraea annettae, Pterynotus erinaceoides, small Turridae, and the common mollusks. At only a very low spring tide is a small sandbar exposed on which have been found Terebra berryi, T. variegata, Cancellaria obesa, and Strombus galeatus in shallow water.

2. Shore similar to (1) except rocks are larger and, in addition to the above, Coralliophila squamosa, Cymatium gibbosum, Heliacus bicanaliculatus are encountered.

3. Shore of large rocks, cliffs, caves.

4. Medium-sized rocks with much plant growth. On this growth are found Mitra tristis, Parametaria duponti, Trivia solandri, Jenneria pustulata, Cypraea annettae, Arca pacifica, A.


to San Felipe
Puertecitos
Baja California
N
9
10
12
11
13
8
7
6
14
18
15
5
16
17
to San Luis Gonzaga
Gulf of California
4
3
1
2
Sand Bars
Rocky Areas
Rocky Reefs
0
100
200
300
400
500
Scale in feet

mutabilis, Modiolus capax, Fusinus felipensis, F. ambustus, and at a very low tide the gorgonians are uncovered and Neosimnia and Cyphoma may be found.

5. This area consists of coarse sand and broken shells with draining runnels in which are found Olivella, Hormospira maculosa, Terebra berryi, and Conus ximenes.

6. Typical sandbar with Terebra variegata and Cassis centiquadrata.

7. An area of small tidepools with runnels and rocks on the reef. Shells found here are Trigonostoma goniostoma, Muricanthus nigritus, Hexaplex erythrostomus, Crassispira nymphia, C. grandimaculata, and others.

8. This is a small area of low lying rocky reefs from which come almost all of the borers, including Lithophaga, Petricola, and Gregariella.

9. Here are numerous small- and medium-sized rocks on which are Ostrea palmula. Under the rocks are O. angelica, Plicatula anomioides, Phenacolepas osculans, and Chitons, Tegulas, Acanthinas, and Pinnas.

10. Fair-sized sand flat that remains wet and yields Tagelus, Solen rosaceus, and Diplodontas.

11. Large sandbar that is exposed at almost all low tides and has the usual sand dwellers, such as Terebra variegata, Glycymeris, Trachycardium, Polinices, and Natica.

12. This is a good place to dig Semele, Diplodonta, and Protothaca.

13. A unique area because where the rocky shore meets the sand there is a zone of mud interspersed with rocks where Crassispira is found. Pitar concinnus occurs on the sandbar close by.

14. Sandy area where Terebra armillata, Olivella, Oliva, Donax gracilis, and D. navicula can be found.

15. On this sandbar, bare at low tide, are Terebra, Donax, Olivella fletcheri, O. dama, Oliva incrassata, Laevicardium elatum, Dosinia, and Polinices.

16. A rocky shore with medium- and large-sized rocks under which, or at night, may be found Acmaea, Turridae, Chitons, Trivia, and Cypraea.

17. Rocky shore with large rocks and sandy tidepools. Cassis coarctata has been taken here.

18. Medium-sized rocks in an exposed area. When the Gulf is rough, this is a very exposed area; therefore, only the hardier forms are found, such as Acmaea, Chitons, Nerita, and Acanthina.

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Pelecypoda

*5 Nuculana costellata (Sowerby, 1833); rare (1), sand beach, low tide, Santa Inez Bay south (Ch).

12 Nuculana impar (Pilsbry & Lowe, 1932); rare (2), sand beach (Sh, D).

36 Arca mutabilis (Sowerby, 1833); common under rocks, low tide (Sh, D, Sp, Co, K, Ch, Ca, H).

37 Arca pacifica (Sowerby, 1833); common around rocks, intertidally (Sh, D, Sp, Co, K, Ch, Ca, H).

38 Arca lurida (Sowerby, 1833); one valve (H).

39 Barbatia bailyi (Bartsch, 1931); one valve (H).

40 Barbatia gradata (Broderip & Sowerby, 1829); (H).

43 Barbatia reeveana (Orbigny, 1846); common intertidally (Sh, D, Sp, Co, K, Ch, Ca, H).

*44 Barbatia illota (Sowerby, 1833); common attached to rocks, intertidally, Angel de la Guarda Island south to Peru (Sh, D, Sp, Co, K, Ch, Ca, H).

46 Arcopsis solida (Sowerby, 1833); common attached to rocks, intertidally (Sh, D, Co, K, Ch, Ca, H).

57 Anadara multicostata (Sowerby, 1833); rare (4), on sandbar, low tide (Sh, Sp, Co, K).

*69 Noetia reversa (Sowerby, 1833); low tide, around rocks, rare (2), Concepción Bay south (K, Ch).

Glycymeris sp.; around rocks, low tide, rare (1) (Ca).

75 Glycymeris maculata (Broderip, 1832); sand beach, uncommon (Sh, D, Sp, K, Ca, H).

76 Glycymeris multicostata (Sowerby, 1833); uncommon, sand beach (Sh, K, Ch, H).

80 Brachidontes multiformis (Carpenter, 1855); uncommon, attached to rocks and rubble, low tide (Sh, Sp, Co, H).

83 Hormomya adamsiana (Dunker, 1857); intertidally among rubble, common (Sh, D, Ch, H).

85 Mytella guyanensis (Lamarck, 1819); among rocks in sand, rare (1) (H).

86 Mytella speciosa (Reeve, 1857); (Ch).

90 Lithophaga aristata (Dillwyn, 1817); in Spondylus calcifer, common (Sh, K, Ch, Ca, H).

91a Lithophaga attenuata rogersi Berry, 1957; boring into coralline rubble, common (Sh, D, Sp, K, Ch, Ca, H).

94 Lithophaga plumula (Hanley, 1843); (Sh, Sp, Ca).

95 Lithophaga spatiosa (Carpenter, 1856); common (Sh, Sp, K, Ch, H).

98 Gregariella coarctata (Carpenter, 1856); boring into reef (Ch, H, Ca).

101 Modiolus capax (Conrad, 1837); attached to rocks, intertidally, common (Sh, D, Co, K, Ch, H).

106 Lioberus salvadoricus (Hertlein & Strong, 1946); attached to rocks, intertidally (Sh, Ch, Ca).

107 Pteria sterna (Gould, 1851); (K, H, Ca).

108 Pinctada mazatlanica (Hanley, 1856); (H).

*110 Vulsella pacifica Dall, 1916; rare (1) Nicaragua (Ch).

*111 Pinna rugosa Sowerby, 1835; tip of Baja California to Panama (Sp, K, Ch, Ca, H).

112 Atrina maura (Sowerby, 1835); between rocks, low tide, juveniles (Sh, K, Ca).

113 Atrina tuberculosa (Sowerby, 1835); (Sp, H).

115 Isognomon chemnitzianus (Orbigny, 1853); attached to rocks, intertidally, common (Sh, D, Sp, Co, K, Ch, Ca, H).

116 Isognomon janus Carpenter, 1856; attached to rocks, intertidally, uncommon (Sh, D, Co, K, Ch, Ca, H).

117 Ostrea angelica Rochebrune, 1895; on rocks, intertidally, uncommon (K, Ch, Ca).

119 Ostrea cf. O. conchaphila Carpenter, 1856; on rocks, low tide, rare (1) (Ch).

124 Ostrea palmula Carpenter, 1856; on rocks exposed to surf, common (Sh, D, Sp, Co, K, Ca).

126 Pecten vogdesi Arnold, 1906; beach valves (D, Co, K, Ca).

132 Aequipecten circularis (Sowerby, 1835); sand beach, juveniles, common (Sh, D, Sp, Co, K, Ch, H).

141 Lima hemphilli Hertlein & Strong, 1946; rare (1) (H).

142 Lima orbignyi Lamy, 1930; under boulders, low tide, uncommon (D, Ch, Ca).

144 Lima pacifica Orbigny, 1846; under boulders, low tide, not uncommon (Sh, D, Sp, Co, H).

145 Spondylus princeps Broderip, 1833; rare (1) (H).

146 Spondylus calcifer Carpenter, 1856; below low-tide level (Sh, D).

Spondylus ursipes Berry, 1959; below low-tide level, rare (1) (H).

147 Plicatula anomioides Keen, 1958; attached to flat rocks, intertidally, common (Sh, D, Sp, K, Ch, Ca, H).

148 Plicatula inezana Durham, 1950; attached to flat rocks, low tide, rare (1) (Co).

150 Plicatula spondylopsis Rochebrune, 1895; rare (1) (H).

152 Anomia peruviana Orbigny, 1846; attached to Donax, intertidally, uncommon (K).

159 Crassinella pacifica (C. B. Adams, 1852); living specimens from siftings 5 to 10 feet below low tide (Sh).

162-2 Cardita affinis californica Deshayes, 1854; attached to rocks, low tide, common (Sh, D, Sp, Co, K, Ch, Ca, H).

167 Cardita cf. C. radiata Sowerby, 1833; under rocks, attached by byssus, low tide (D).

185 Lucina lampra (Dall, 1901); intertidally, 6 to 18 inches in sand with Tagelus californianus, uncommon (Ch, Ca, H).

187 Lucina prolongata Carpenter, 1855; intertidally (H).

200 Codakia distinguenda (Tryon, 1872); freshly dead in pairs, sandy drainage channels and in octopus holes, common (Sh, D, Sp, Ch, Ca, H).

201 Ctena chiquita (Dall, 1901); rare (1) (H).

205 Ctena mexicana (Dall, 1901); low tide, sand beach, common (Sh, Sp, Co, K, Ch, Ca, H).

206 Divalinga eburnea (Reeve, 1850); dead valves on beach near high-tide level, rare (1) (Ca).

*208 Diplodonta inezensis (Hertlein & Strong, 1947); rare (1), Santa Inez Bay (Ch).

209 Diplodonta orbellus (Gould, 1851); sandy nests under rocks, intertidally, common (Sh, D, Sp, Co, K, Ch, Ca, H).

212 Diplodonta sericata (Reeve, 1850); under rocks, intertidally, common (Sh, D, Co, K, Ch, H).

*213 Diplodonta caelata (Reeve, 1850); rare (1), Sihuatanejo, Mexico, south to Ecuador (H).

214 Diplodonta semirugosa Dall, 1899; out of Chama buddiana (Co, H).

218 Basterotia peninsularis Jordan, 1936; dead specimen (Ch).

221 Ensitellops hertleini Emerson & Puffer, 1957; rare (1) (H).

236 Solecardia eburnea Conrad, 1849; intertidally, uncommon, valves only (K, Ch, Ca).

237 Sportella stearnsii Dall, 1899; living on sea cucumbers (holothuria), rare (1) (Ca).

238 Chama buddiana C. B. Adams, 1852; attached to rocks, intertidally, common (Sp, D, Co, K, Ch, H).

241 Chama sordida Broderip, 1835; attached to rocks, rare (1) (H).

242 Chama squamuligera Pilsbry & Lowe, 1932; attached to rocks, intertidally, rare (1) (H).

248 Pseudochama saavedrai Hertlein & Strong, 1946; attached to conglomerate, low tide, rare (2) (D, Ch).

252 Trachycardium panamense (Sowerby, 1833); muddy sand beach, low tide, common (Sh, D, Co, K, Ch, Ca, H).

255 Papyridea aspersa (Sowerby, 1833); muddy sand beach, low tide, common (Sh, D, Sp, Co, K, Ch).

256 Trigoniocardia granifera (Broderip & Sowerby, 1829); mud flats, low tide, uncommon (Sh, D, H).

258 Trigoniocardia biangulata (Broderip & Sowerby, 1829); intertidally, common (Sh, D, Sp, K, Ch).

262 Laevicardium elatum (Sowerby, 1833); sand beach, low tide, uncommon (Sh, Sp, Co, K, Ca).

263 Laevicardium elenense (Sowerby, 1840); muddy sand beach and sandbars, low tide, common (Sh, D, K, Ch, Ca).

*270 Gouldia californica Dall, 1917; rare (1) La Paz to Panama (Ch).

273 Tivela byronensis (Gray, 1838); sand beach, intertidally, common (Sh, D, Sp, Co, Ch, Ca, H).

280 Transennella puella (Carpenter, 1864); uncommon, sand beach, low tide (D). Transennella sp. (Ch).

286 Pitar newcombianus (Gabb, 1865); sand beach, low tide, uncommon (Sh, Ch).

291 Pitar pollicaris (Carpenter, 1864); low tide, rare (1) (Sp).

296 Pitar concinnus (Sowerby, 1835); sand beach, intertidally, fairly common (Sh, K, Ch, Ca, H).

298 Pitar tortuosus (Broderip, 1835); sand beach, uncommon (D, K, Ch).

303 Megapitaria squalida (Sowerby, 1835); muddy sand beach, common (Sh, D, Sp, Co, K, Ch, Ca, H).

306 Dosinia ponderosa (Gray, 1838); muddy sand beach, common (Sh, D, Sp, Co, K, Ch, Ca, H).

318 Chione californiensis (Broderip, 1835); muddy sand beach, common (D, H).

319 Chione compta (Broderip, 1835); dead valves on sand beach (D).

*320 Chione guatulcoensis Hertlein & Strong, 1948; intertidally, sand beach, rare (1), Port Guatulco, Mexico, to Panama Bay (Ch).

321 Chione undatella (Sowerby, 1835); intertidally, sand beach, common (Sh, D, Sp, Co, Ch, H).

323 Chione fluctifraga (Sowerby, 1853); sand beach, dead valve (D).

326 Chione gnidia (Broderip & Sowerby, 1829); intertidally, muddy sand, uncommon (H).

327 Chione pulicaria (Broderip, 1835); intertidally, sand beach, common (Sp, D, K, Ch, Ca).

328 Chione purpurissata Dall, 1902; intertidally, rare (1) (H).

331 Chione mariae (Orbigny, 1846); low tide, sand beach, rare (4) (Sh, Sp, Ch, H).

335 Chione picta Willett, 1944; low tide, sand beach, rare (4) (Sh, Sp, Ch, H).

*337 Anomalocardia subimbricata tumens (Verrill, 1870); low tide, sandbars, rare (2), southern part of the Gulf of California (D, H).

340 Protothaca grata (Say, 1831); muddy sand and rubble, intertidally, common (Sh, D, Sp, Co, Ch, Ca, H).

341 Protothaca asperrima (Sowerby, 1835); sand beach and rubble, intertidally, uncommon (D, K, Ca).

345 Petricola lucasana Hertlein & Strong, 1948; in crevices, common (Sh, D, K, Ch, H, Ca).

*347 Petricola denticulata Sowerby, 1834; on reef with Lithophaga, rare (2), La Paz to Peru (K, H).

348 Petricola parallela Pilsbry & Lowe, 1932; valves on beach (Ch).

349 Petricola robusta Sowerby, 1834; boring in clay (Ch).
Petricola botula Olsson, 1961; one complete dead specimen (Ca).
352 Cooperella subdiaphana (Carpenter, 1864); sand beach, intertidally (Sp, Ch).
355 Mactra dolabriformis (Conrad, 1867); muddy sand flat (Sp, D, Ca, H).
356 Mactra nasuta Gould, 1851; intertidally, rare (1) (Sp).
376 Tellina inaequistriata Donovan, 1802; sand beach, rare (1) (Ch).
*381 Tellina prora Hanley, 1844; muddy sand, low tide, rare (1), La Paz to Ecuador (D).
*383 Tellina rubescens Hanley, 1844; intertidally, rare (1), Tenacatita Bay, Mexico, to Peru (H).
384 Tellina simulans C. B. Adams, 1852; muddy sand, low tide, uncommon (D, K).
387 Tellina cristallina Spengler, 1798; one valve, rare (H).
389 Tellina meropsis Dall, 1900; muddy sand, low tide, rare (K, Ch).
393 Tellina arenica Hertlein & Strong, 1949; rare (Ch).
*398 Tellina guaymasensis Pilsbry & Lowe, 1932; muddy sand, low tide, rare (1), Guaymas, Mexico (Ch).
Tellina, a new species, to be described by Dr. Myra Keen; sand beach, uncommon (D).
Macoma indentata Carpenter, 1864; rare (H).
*435 Macoma cf. M. mazatlanica (Deshayes, 1855); rare (1), Mazatlán (Sh).
436 Macoma pacis Pilsbry & Lowe, 1932; sand beach, low tide, uncommon (D, Ch, Ca, H).
439 Strigilla costulifera (Mörch, 1860); rare (2) (Sh, Ca).
441 Strigilla lenticula Philippi, 1846; intertidally, sand beach, rare (1) (D).
450 Donax gracilis Hanley, 1845; common, sand flats (Sh, D, Sp, Co, Ca).
451 Donax navicula Hanley, 1845; intertidally, sand flats, common (Sh, D, Sp, K, Ch, Ca, H).
462 Sanguinolaria tellinoides A. Adams, 1850; rare (1) (H).
467 Heterodonax bimaculatus (Linnaeus, 1758); uncommon (Sh, H).
471 Tagelus californianus (Conrad, 1837); mud flats, actively burrowing, common (Sh, D, Sp, Co, K, Ch, Ca, H).
472 Tagelus violascens (Carpenter, 1855); mud flats, rare (1) (Ch).
477 Semele bicolor (C. B. Adams, 1852); mud flats, rare (2) (Ch, Ca).
481 Semele flavescens (Gould, 1851); under rocky rubble, low tide, common (Sh, D, Sp, K, Ch, Ca).
482 Semele formosa (Sowerby, 1832); rare (1) (K).
483 Semele guaymasensis Pilsbry & Lowe, 1932; rocky rubble, low tide, uncommon (Sh, D, Ch).
508 Cumingia lamellosa Sowerby, 1833; nestling in rock crevices, intertidally, uncommon (Sh, Ca).
*512 Solen cf. S. mexicanus Dall, 1899; rare, Gulf of Tehuantepec, Mexico, to Nicaragua (K).
516 Solen rosaceus Carpenter, 1864; intertidally, in runnels, rare (2) (D, Ca).
518 Ensis californicus Dall, 1899; intertidally, in runnels, rare (2) (D, K).
521 Sphenia fragilis Carpenter, 1856; nestling in cavities and holes (D, Ch, H).
523 Corbula bicarinata Sowerby, 1833; around rocks, low tide, fairly common (Sh, D, Sp, Ch, Ca).
524 Corbula biradiata Sowerby, 1833; around rocks, intertidally (Ch, Ca).
525 Corbula cf. C. luteola Carpenter, 1864; in dead Semele flavescens, sand beach (D).
527 Corbula nasuta Sowerby, 1833; around rocks, intertidally, uncommon (Sh, Ch).
538 Corbula tenuis Sowerby, 1833; in beach drift (H).
542 Hiatella arctica (Linnaeus, 1767); in rocky crevices, intertidally (Sh, Co, Ch).
546 Pholas chiloensis Molina, 1782; beach specimen (Ch).
553 Diplothyra curta (Sowerby, 1834); rare (1) (H).
573 Pandora granulata Dall, 1915; (Sh).
578 Lyonsia gouldii Dall, 1915; sand beach, low night tide, uncommon (Sh, D, Ch).
579 Lyonsia inflata Conrad, 1837; in crevices, rocky reef, uncommon (Sh, D).
585 Periploma planiusculum Sowerby, 1834; low tide, uncommon (Sh).
589 Thracia curta Conrad, 1837; dead valve (K).

Scaphopoda

2 Dentalium inversum Deshayes, 1826; beach specimen (Ch, Ca).
Dentalium sp.; alive on sand beach (Ca).
Dentalium sp.; in sand near boulder, low tide, beach specimen, rare (D).
12 Cadulus panamensis Pilsbry & Sharp, 1897; below low-tide level (Ch).

Gastropoda

Acmaea acutapex Berry, 1960; common on rocks at mid-tide level (D, Sp, K, Ch).

*5 Acmaea filosa Carpenter, 1865; rare (1), El Salvador to Panama (H).

7 Acmaea mitella Menke, 1847; among big barnacles (H).

7a Acmaea mitella fayae Hertlein, 1958; mid-tide level, rare (2) (D, Sp).

12a Acmaea strongiana Hertlein, 1958; on rocks at mid-tide level, common (Sh, D, Sp, Co, K, Ch, Ca, H).

14 Acmaea turveri Hertlein & Strong, 1951; on rocks at high-, mid-tide level, common (Sh, Sp, K, Ch, Ca, H).

16 Nomaeopelta dalliana (Pilsbry, 1891); mid-tide level, common (Sh, D, Sp, Co, K, Ch, Ca, H).

Nomaeopelta goodmani Berry, 1960; high-tide level, uncommon (topotypes) (D, Sp, K, Ch, Ca, H).

18 Nomaeopelta stanfordiana (Berry, 1957); mid-tide level, common (Sh, D, Sp, K, Ch, Ca).

*28 Lucapinella aequalis (Sowerby, 1835); uncommon, Port Guatulco, Mexico, to Ecuador (D, H).

Lucapinella milleri Berry, 1960; rare (1) (Ch).

*30 Diodora alta (C. B. Adams, 1852); mid-tide level, common (Sh, D, Sp, Co, K, Ch, Ca, H).

Diodora constantiae Kanakoff, 1953; under boulders, rare (1) (H).

32 Diodora inaequalis (Sowerby, 1835); mid-tide level, under rocks (Sh, D, Sp, Co, K, Ch, Ca, H).

*33 Diodora panamensis (Sowerby, 1835); rare (1), on rocks, Panama (Ch).

34 Diodora saturnalis (Carpenter, 1864); mid-tide level, on rocks, rare (2) (Sh, D).

41 Calliostoma eximium (Reeve, 1843); under rocks, mid-tide level, rare (2) (Sp, K).

45 Calliostoma marshalli Lowe, 1935; under rocks, mid-tide level, rare (2) (Sh, Ch).

47 Calliostoma palmeri Dall, 1871; beach specimen (D).

52 Tegula globulus (Carpenter, 1856); under and on rocks, high-tide level, common (Sh, Co, Ch).

53 Tegula ligulata (Menke, 1850); on rocks, rare (1) (Ch).

54 Tegula mariana Dall, 1919; under and on rocks, high-tide level, common (Sh, D, Sp, Co, K, Ch).

58 Tegula rugosa (A. Adams, 1853); on rocks, high-tide level, common (Sh, D, Sp, Co, K, Ch).

64 Turbo fluctuosus Wood, 1828; among stones, mid-tide level, common (Sh, D, Sp, Co, K, Ch, Ca).

*67 Turbo saxosus Wood, 1828; juveniles only, Los Angeles Bay, Gulf of California, to Peru (Ch).

Liotia acuticostata Carpenter, 1864; beach specimen (Ch).

Liotia carinata Carpenter, 1864; (Ch).

Liotia rammata Dall, 1918; (Ch).

Tricolia substriata (Carpenter, 1864); under rocks (D, Ch).

81 Nerita scabricosta Lamarck, 1822; high-tide level, common (Sh, D, Sp, Co, K, Ca, H).

82 Nerita funiculata Menke, 1851; on rocks, intertidally, common (Sh, Sp, Co, K, Ch, Ca).

85 Phenacolepas malonei Vanatta, 1912; on rocks, intertidally, rare (3) (Sp, Co, Ch).

86 Phenacolepas osculans (C. B. Adams, 1852); on rocks, intertidally, rare (2) (Sh, D).

Eulima sp.; dead specimen (D).

Balcis sp.; two species (Sh).

98 Epitonium vivesi Hertlein & Strong, 1951; rare (1) (Sh).

99 Epitonium walkerianum Hertlein & Strong, 1951; under rocks, rare (2) (Sh, D).

*113 Epitonium cf. E. colpoicum Dall, 1917; under rocks, rare (1), La Paz to Panama (D).

121 Epitonium hexagonum (Sowerby, 1844); rare (2) (Ca, H).

124 Epitonium oerstedianum Hertlein & Strong, 1951; rare (1) (H).

*158 Opalia diadema (Sowerby, 1832); under rocks, low tide, rare (1), Mazatlán, Mexico, to Galapagos Islands (D).

165 Opalia retiporosa (Carpenter, 1864); rare (2) (Sp, Ch).

175 Littorina dubiosa penicillata Carpenter, 1864; common on rocks at splash zone (Sh, D, Sp, Co, Ch, Ca, H).

Cyclostremiscus granti Baker, Hanna, & Strong, 1938; in siftings, 5 to 10 feet below low-tide level, one specimen (Sh).

Macromphalina sp.; in siftings, 5 to 10 feet below low-tide level (Sh).

Chonebasis symmetrica Pilsbry & Olsson; below low-tide level (H).
Solariorbis sp.; in siftings, 5 to 10 feet below low-tide level (Sh).
Teinostoma amplectans Carpenter, 1857; sand beach, just below low-tide level (Sh, D, H).
Teinostoma sp.; (H).
Vitrinella sp.; sand beach, just below low-tide level (Sh, Co).
Assiminea sp. (Sh).
Rissoina burragei Bartsch, 1915 (D, Ch).
Rissoina firmata C. B. Adams, 1852 (H).
Rissoina or Rissoella (Sh).
Rissoina woodwardii Carpenter, 1856; just below low-tide level, sand beach (Sh).
Barleeia sp. (Ch).
180 Turritella anactor Berry, 1957; sand beach, low tide, uncommon; all beach specimens (D, Co, Ch, Ca).
189a Vermicularia pellucida eburnea (Reeve, 1842); among rubble, low tide, good specimens uncommon (D, Co, Ch, Ca).
191 Architectonica nobilis Röding, 1798; beach specimens, rare (2) (D).
193 Heliacus bicanaliculatus (Valenciennes, 1832); intertidally, in runnels, uncommon (D, K, Ch).
*194 Heliacus planispira Pilsbry & Lowe, 1932; extreme low tide, Panama (Sh).
Caecum sp.; in siftings, 5 to 10 feet below low-tide level (Sh, H).
Elephantanellum, two species; in siftings, 5 to 10 feet below low-tide level (Sh, H).
Elephantulum sp.; in dead Semele flavescens, common (D, Ch).
Elephantulum sp.; in siftings, 5 to 10 feet below low-tide level (Sh, D).
Fartulum sp.; in siftings, 5 to 10 feet below low-tide level (Sh, D, H).
Micranellum sp.; in dead Semele flavescens (D, H).
196 Modulus cerodes (A. Adams, 1851); muddy sand flats, uncommon (Sp).
197 Modulus disculus (Philippi, 1846); on muddy coralline reef, common (D, Sp, Co, K, Ch, Ca).
198 Vermetus centiquadrus Valenciennes, 1846; on rocks, fairly common (K, Ca).
201 Vermetus indentatus (Carpenter, 1856); among rocks, mid-tide, uncommon (K, Ca, H).
203 Petaloconchus macrophragma Carpenter, 1856; among rocks, mid-tide, rare (2) (Ch, Ca).
211 Cerithium maculosum Kiener, 1841; on rocky reef, intertidally, uncommon (K, Ca).
214 Cerithium sculptum Sowerby, 1855; under rocks, intertidally, common (Sh, D, Sp, Co, K, Ch, Ca).
215 Cerithium stercusmuscarum Valenciennes, 1833; muddy sand flats, intertidally, common (Sh, D, Co, K, Ch, Ca).
Triphora, three species (Sh, D).
Triphora contrerasi Baker, 1926 (Ch).
Bittium sp. (D).
Cerithiopsis bristolae Baker, Hanna, & Strong, 1938; (Sh).
Cerithiopsis sp. (Sh, D, Ch).
Seila assimilata C. B. Adams, 1852; sand beach, low tide (Sh, Ch).
Alaba jeannettae Bartsch, 1911 (Ch, H).
Alabina diomedae Bartsch, 1911 (Sh).
Alabina tenuisculpta Carpenter, 1864; (Ch).
219 Cerithidea albonodosa Gould & Carpenter, 1857; muddy sand, high-tide level, uncommon (K, Ca).
225 Hipponix antiquatus (Linnaeus, 1767); on rocks, intertidally, common (Sh, D, Ch).
227 Hipponix pilosus (Deshayes, 1832); on rocks, intertidally, common (Sp, D, Co, K, Ch, Ca).
Fossarus angiostoma C. B. Adams, 1852; (H).
Fossarus megasoma C. B. Adams, 1852; (H).
Fossarus cf. F. tuberosus Carpenter, 1857; under rocks, intertidally, rare (1) (Sh).
Iselica sp.; sand beach, low tide (Sh, D, Sp).
230 Vanikoro aperta (Carpenter, 1864); rare (1), Cape San Lucas, Baja California (H).
Vanikoro sp. (Ch).
233 Calyptraea mamillaris Broderip, 1834; attached to rocks and other shells, intertidally, fairly common (D, K, Ch, Ca).
237 Cheilea cepacea (Broderip, 1834); rare (Ch).
240 Crepidula arenata (Broderip, 1834); on dead shells, intertidally, not common (D).
241 Crepidula excavata (Broderip, 1834); on other shells, low tide, uncommon (D, Ch).
242 Crepidula incurva (Broderip, 1834); on dead shells, common (Sh, D, Sp, Co, K, Ch, H).
*243 Crepidula lessonii (Broderip, 1834); under stones, intertidally, rare, Oaxaca, Mexico, to Peru (D).
245 Crepidula onyx Sowerby, 1824; common, especially on Cypraea annettae, low tide (D, K, H).

246 Crepidula perforans (Valenciennes, 1846); in pholad holes, uncommon (Co, Ch).

248 Crepidula striolata Menke, 1851; attached to underside of stones, intertidally, common (Sh, D, Sp, Co, K, Ch).

249 Crepidula uncata Menke, 1847; attached to gorgonians and dead shells, rare (Sh, H).

252 Crucibulum scutellatum (Wood, 1828); on rocky reefs, intertidally, uncommon (D, Sp, K, Ch).

254 Crucibulum spinosum (Sowerby, 1824); on dead shells and rocks, intertidally, uncommon (D, Sp, Co, K, Ch, Ca).

258 Natica chemnitzii Pfeiffer, 1840; sand flats, low tide, common (Sh, D, Sp, Co, K, Ch, Ca, H).

266 Polinices bifasciatus (Gray, 1834); sand flats, low tide, common (Sh, D, Sp, Co, K, Ca, H).

272 Polinices uber (Valenciennes, 1832); sand flats, low tide, common (Sh, D, Sp, Ch, Ca, H).

274 Polinices reclusianus (Deshayes, 1839); sandbars, intertidally, common (Sh, D, Co, K, Ch, Ca, H).

275 Sinum cf. S. debile (Gould, 1853 [1852]); on tide flats, low tide, rare (Sh).

*280 Lamellaria inflata (C. B. Adams, 1852); near boulder, brown soft parts, rare (1), Panama (D).

287 Cypraea annettae Dall, 1909; under rocks, low tide, common (Sh, D, Sp, Co, K, Ch, Ca, H).

289 Erato columbella Menke, 1847; under rocks, low tide, rare (Ch).

296 Trivia californiana (Gray, 1828); on boulders, low tide, dead specimens only (D, K).

299 Trivia solandri (Sowerby, 1832); on boulders, low tide, uncommon (Sh, D, Sp, Co, Ch, Ca, H).

*300 Jenneria pustulata (Solander, 1786); under and on rocks, low tide, rare, southern end of Gulf of California to Ecuador (Sh, D, Sp, Ca).

*301 Cyphoma emarginatum (Sowerby, 1830); on gorgonians, rare, Mazatlán, Mexico, to Ecuador (Sh, Ca).

305 Neosimnia quaylei (Lowe, 1935); on gorgonians, shallow water (Sh, D, Sp, K, Ca).

307 Strombus galeatus Swainson, 1823; muddy runnels, around rocks, low tide, common (Sh, D, Sp, Co, K, Ch, Ca, H).

308 Strombus gracilior Sowerby, 1825; muddy sand flats, low tide, common (Sh, D, Sp, Co, K, Ch, H).

309 Strombus granulatus Swainson, 1822; around rocks, in runnels, uncommon (Sh, D, K, Ca, H).

*313 Cassis coarctata Sowerby, 1825; rare, among boulders, La Paz, Gulf of California, to Ecuador (Ca).

315 Cassis centiquadrata (Valenciennes, 1832); around rocks and on sandbars at very low tide, uncommon (Sp, Ch).

317 Ficus ventricosa (Sowerby, 1825); beach specimens and dredged by shrimp boats (K, Ca).

324 Cymatium gibbosum (Broderip, 1833); under rocks, intertidally, uncommon (Sh, D, Sp, Ch).

335 Murex elenensis Dall, 1909; dead specimens on beach (Sh, K, Ca, H).

339 Hexaplex erythrostomus (Swainson, 1831); juveniles on and around rocks and on rocky reefs, adults at low tide on sand beach, common (Sh, D, Sp, Co, K, Ch, Ca, H).

344 Muricanthus nigritus (Philippi, 1845); uncommon except as juveniles among rocks, low tide (Sh, D, Co, K, Ch, Ca, H).

348 Pterynotus erinaceoides (Valenciennes, 1832); among rocks, low tide, common (Sh, D, Sp, K).

358 Ocenebra parva (E. A. Smith, 1877); between rocks, low tide, rare (1) (D).

367 Muricopsis armatus (A. Adams, 1854); beach specimen (Ca).

*369 Muricopsis zeteki Hertlein & Strong, 1951; under rocks, low tide, uncommon, Mazatlán, Mexico, to Panama (Sh, D, Sp).

387 Coralliophila costata (Blainville, 1832); coral reef, low tide, uncommon (Sh, D, Sp).

388 Coralliophila hindsii (Carpenter, 1857); beach specimen (Ch).

389 Coralliophila squamosa (Broderip, 1833); under rocks, low tide, rare (1) (Sp).

398 Thais biserialis (Blainville, 1832); under rocks, intertidally, rare (2) (Sp, Ca).

404 Acanthina angelica I. Oldroyd, 1918; mid-tide level, common (Sh, Sp, Co, K, Ch, Ca, H).

409 Acanthina tuberculata (Sowerby, 1835); on rocks, intertidally, common (Sh, D, Co, K, Ch, H).

411 Morula ferruginosa (Reeve, 1846); under rocks, intertidally, common (Sh, D, Sp, Co, K, Ch, H).

412 Morula lugubris (C. B. Adams, 1852); under rocks, uncommon (Sh, D).

424 Anachis coronata (Sowerby, 1832); under rocks, intertidally, common (Sh, D, Sp, Co, K, Ch, Ca, H).

429 Anachis diminuta (C. B. Adams, 1852); on rocks, low tide, uncommon (Sh, D, Ca).

*437 Anachis hilli Pilsbry & Lowe, 1932; under rocks, intertidally, uncommon, Sonoran coast of Mexico to Nicaragua (Sh, D, Sp, Co, Ca, H).

444 Anachis nigricans (Sowerby, 1844); under rocks, intertidally, uncommon (Sh, D, Sp, K, Ca, H).

454 Anachis sanfelipensis Lowe, 1935; under rocks, intertidally, common (Sh, D, Sp, Co, K, Ch, Ca).

455 Anachis scalarina (Sowerby, 1832); under rocks, intertidally, common (Sh, D, Ca).

464 Anachis varia (Sowerby, 1832); under rocks, intertidally, common (Sh, D, Sp, Co, K, Ch, Ca).

470 Cosmioconcha palmeri (Dall, 1913); under rocks, rare (1) (D).

*478 Mitrella dorma Baker, Hanna, & Strong, 1938; under rocks, low tide, uncommon, southern part of Gulf of California (Sh, D, Sp).

480 Mitrella granti Lowe, 1935; under rocks, low tide, rare (2) (Sh, Sp).

*482 Mitrella lalage Pilsbry & Lowe, 1932; on rocks, extreme low tide, uncommon, southern part of Gulf of California (D, Ch).

483 Mitrella millepunctata (Carpenter, 1864); on rocks, extreme low tide, rare (2) (D, Sp).

484 Mitrella ocellata (Gmelin, 1791); under rocks, intertidally, common (Sh, D, Sp, Co, Ch).

Nassarina, probably a new species; in siftings from 5 to 10 feet below low-tide level (Sh).

494 Parametaria dupontii (Kiener, 1849-50); under rocks, intertidally, common (Sh, D, Sp, Co, K, Ch, Ca).

497 Pyrene fuscata (Sowerby, 1832); under rocks, intertidally, common (Sh, D, Sp, Co, K, Ch, Ca).

515 Strombina maculosa (Sowerby, 1832); muddy sand, among rocks, uncommon (D, Sp, K, Ca).

541 Cantharus capitaneus (Berry, 1957); beach specimen (Ch, Ca).

543 Cantharus macrospira (Berry, 1957); muddy sand (Sh, Sp, Co, Ch, Ca).

*551 Engina solida (Dall, 1917); under rocks, low tide, rare, La Paz, Gulf of California to Acapulco, Mexico (Sh, D, Ca).

*586 Nassarius taeniolatus (Philippi, 1845); rare, around and under rocks, Acapulco, Mexico, to Chile (Sh).

587 Nassarius versicolor (C. B. Adams, 1852); around rocks and on sand flats as tide recedes, common (Sh, D, Sp, Co, Ca, H).

591 Nassarius iodes (Dall, 1917); around rocks as tide recedes, common (D, Co, K, Ch).

592 Nassarius luteostoma (Broderip & Sowerby, 1829); around rocks as tide recedes, uncommon (D, K).

593 Nassarius moestus (Hinds, 1844); around rocks as tide recedes, common (Sh, D, Sp, Co, K, Ch, Ca, H).

595 Nassarius tiarula (Kiener, 1841); around rocks as tide recedes, common (Sh, D, Sp, K, Ch).

612 Fusinus ambustus (Gould, 1853 [? 1852]); on muddy sandflats, intertidally, common (Sh, D, K, Ch, Ca).

617 Fusinus cinereus (Reeve, 1847); (H).

618 Fusinus felipensis Lowe, 1935; on rocky reef, intertidally, common (Sh, D, Sp, Co, Ch, Ca).

620 Oliva incrassata (Solander, 1786); on sand flats as tide turns, common (Sh, D, Sp, Co, K, Ch, Ca, H).

625 Oliva spicata (Röding, 1798); sand flats, low tide, rare (2) (K, H).

627 Oliva undatella Lamarck, 1810; sand beach, low tide, common (Sh, D, Sp, Co, Ca, H).

634 Olivella dama (Wood, 1828); sand flats as tide turns, common (Sh, D, Sp, Co, K, Ch, Ca).

634a Olivella fletcherae Berry, 1958; sand flats as tide turns, common (Sh, D, Sp, K, Ch).

*640 Olivella volutella (Lamarck, 1811); sand beach, rare (2), Central America to Ecuador (D, K).

645 Olivella zanoeta (Duclos, 1835); sand flats as tide turns, common (Sh, D, Sp, Co, K, H).

Olivella sp. (D).

646 Mitra solitaria C. B. Adams, 1858; among rocks, low tide, uncommon (Sh, D, Sp, Ch, Ca, H).

656 Mitra tristis Broderip, 1836; under rocks, intertidally, common (Sh, D, Sp, Co, K, Ch, Ca, H).

662 Mitra sulcata Sowerby, 1825; beach specimens (D, Sp).

Mitra fultoni; under rocks, intertidally, rare (1) (Sp).

667 Lyria pedersenii (Verrill, 1870); under rocks, low tide, rare (1) (Ch).

669 Marginella californica Tomlin, 1916; under muddy rocks, uncommon (Sh, H).
Cystiscus sp. (Sh).
685 Cancellaria obesa Sowerby, 1832; sand spits, low tide at night, rare (4) (Sh, D, Sp, Ca).
693 Cancellaria cassidiformis Sowerby, 1832; sand spits, low tide, rare (2) (D, Ca).
710 Trigonostoma goniostoma Sowerby, 1832; rocky reef, low tide, common (Sh, D, Sp, K, Ca, H).
726 Knefastia funiculata (Kiener, 1838-40, ex. Valenciennes MS); rocky reef, low tide, uncommon (D, Sp).
727 Knefastia olivacea (Sowerby, 1833); rocky reef, low tide, common (Sh, D, Sp, Co, K, Ch, Ca).
753 Clavus ianthe (Dall, 1919); sand beach, low night tide, rare (6) (Sh, D, Sp, K, Ca, H).
758 Clavus pembertoni Lowe, 1935; dead specimen (H).
769 Clathrodrillia pilsbryi Lowe, 1935; dead specimens (D, Ca).
*770 Clathrodrillia aenone Dall, 1919; rocky reef, rare (2), Agua Verde Bay, Gulf of California (D, Sp).
*790 Crassispira bacchia Dall, 1919; under rocks, intertidally, rare (3), La Paz, Gulf of California (D, Sp, Ca).
*802 Crassispira erebus Pilsbry & Lowe, 1932; rocky reefs, low tide, uncommon, Southern Mexico to Panama (Sh, D, K, Ch, H).
*809 Crassispira grandimaculata (C. B. Adams, 1852); under rocks, intertidally, uncommon, Nicaragua to Panama (D, Sp, Ca).
815 Crassispira lucasensis (Bartsch, 1950) ? = C. kluthi Jordan, 1936; sand beach and under rocks, low tide, common (Sh, D, Sp, Co, K, Ch, Ca, H).
822 Crassispira nymphia Pilsbry & Lowe, 1932; under rocks, low tide, common (Sh, D, Sp, Co, K, Ch, Ca, H).
825 Crassispira pluto Pilsbry & Lowe, 1932; under rocks, low tide, common (Sh, D, Sp, K, Ch).
*839 Crassispira xanti Hertlein & Strong, 1951; rare (2), southern end of the Gulf of California to Costa Rica (Sh, Sp).
*840 Crassispira zonulata (Reeve, 1843); under rocks, low tide, rare (2), Nicaragua to Panama (Sp, H).
851a Mangelia hamata Carpenter, 1865; intertidally, rare (1) (H).
863a Mangelia cf. M. euryclea Dall, 1919; intertidally, rare (1) (Sp).
Mangelia cf. M. oenoa Dall, 1919; intertidally, rare (1) (Sh).
*866 Mangelia subdiaphana Carpenter, 1864; intertidally, rare (1), Cape San Lucas, Gulf of California (Sp).
*867 Mangelia antiochroa Pilsbry & Lowe, 1932; intertidally, rare (1), Panama (H).
870 Mangelia cyrene Dall, 1919; intertidally, rare (1) (H).
Mangelia doris Dall, 1919; intertidally, rare (1) (H).
Mangelia, two species (Sh, Ch).
*894 Tenaturris cf. T. nereis (Pilsbry & Lowe, 1932); under rocks, low tide, rare (3), Nicaragua (Sh, Sp, Ca).
908 Hormospira maculosa (Sowerby, 1834); among rocky rubble, intertidally, uncommon (D, Sp, K, Ca).
910 Pleuroliria nobilis (Hinds, 1843); washed up by storm, alive (D).
922 Conus princeps Linnaeus, 1758; dead specimen (Ch).
926 Conus perplexus Sowerby, 1857; sand beach, low tide, uncommon (D, Ch, Ca).
930 Conus ximenes Gray, 1839; in coarse sand, edge of runnels, low tide, common (Sh, D, Sp, Co, K, Ca, H).
*948 Terebra robusta Hinds, 1844; sand beach, low tide, rare (2), Guaymas, Mexico, to Ecuador (D).
949 Terebra strigata Sowerby, 1825, cf. T. ornata; beach specimen (D).
956 Terebra armillata Hinds, 1844; muddy sand flats, intertidally, common (Sh, D, Co, Ca, H).
*958 Terebra cf. T. bridgesi Dall, 1908; sand beach, low night tide, uncommon (18), Panama (Sh, D, H).
963 Terebra glauca Hinds, 1844; sand beach, intertidally, uncommon (Sh, D, Ch).
*968 Terebra ligyrus Pilsbry & Lowe, 1932; sand beach, intertidally, rare (1), Guaymas, Mexico (Sp).
980 Terebra variegata Gray, 1834; sand beach, intertidally, common (Sh, D, Co, K, Ca, H).
Terebra berryi Campbell, 1961; sand beach, low tide, rare (2) (D, Ca).
982 Bulla gouldiana Pilsbry, 1895; among rubble as tide recedes, common (Sh, D, Sp, Co, K, Ca, H).
986 Haminoea strongi Baker & Hanna, 1927; rare (4) (Sh, Sp, Ch, H).
992 Acteocina angustior Baker & Hanna, 1927; sand beach, uncommon (Sh, D, Ch).
994 Acteocina inculta (Gould & Carpenter, 1857); sand beach (Sh, D).

Odostomia aepynota planicosta Baker, Hanna, & Strong, 1928; rare (1) (Sh).
Odostomia, three species (Sh).
Turbonilla, three species (Sh).

1025 Pedipes liratus Binney, 1860; rare (2) (Sh, H).

1033 Williamia peltoides (Carpenter, 1864); dead specimen, rare (Ch).

Amphineura

5 Chiton virgulatus Sowerby, 1840; under stones, intertidally, common (D, Co, H).
Acanthochitona cf. A. avicula Carpenter, 1856; rare (1) (H).

9 Acanthochitona exquisita (Pilsbry & Lowe, 1893); crawling on rocks at night, common (D, Sp, Co, Ch, Ca, H).
Lepidopleurus internexus Carpenter, 1865; under rocks (Ch).

27 Callistochiton gabbi Pilsbry, 1893; under stones, intertidally, common (H).

28 Callistochiton infortunatus Pilsbry, 1893; under stones, intertidally, uncommon (H).
Callistochiton palmulatus Carpenter, 1856 (H).

38 Chaetopleura euryplax Berry, 1945; under stones, rare (D).

39 Lepidozona clathrata (Reeve, 1847); under stones and in crevices, uncommon (D, Co, H).

*41 Lepidozona serrata (Carpenter, 1864); under stones, rare, Cape San Lucas, Baja California (H).

42 Lepidozona subtilis Berry, 1956; in crevices, intertidally, common (D, Co, H).
? Stenoplax corrugata (Pilsbry, 1892); (H).

44 Stenoplax limaciformis (Sowerby, 1832); under stones, intertidally, common (Co, H).

45 Stenoplax magdalenensis (Hinds, 1845); under and on rocks, intertidally, common (Ch, H).

46 Stenoplax mariposa (Dall, 1919); under stones, intertidally, common (D, Co, Ch, H).

47 Stenoplax conspicua sonorana Berry, 1956; on rocks and in tidepools (H).

49 Nuttallina crossota Berry, 1956; on rocks and in tidepools (H).
Dendrochiton sp. (H).

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A New Species of *Armina* (Gastropoda : Nudibranchia) from the Gulf of California

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(6 Textfigures)

Of the four suborders of nudibranchiate mollusks, the Arminacea comprises the least number of species. Although highly polymorphous, and in many respects structurally intermediate between doridiform and eolidiform animals, the three families of this suborder known to occur on the Pacific Coast of North America are readily distinguishable from each other. Both the Dironidae and Antiopellidae possess cerata, and in the former a conspicuous frontal veil is also present. In the latter the cerata extend around the anterior portion of the notum. The Arminidae are characterized by the absence of any appendages on the notum, the occurrence of gills on the under surface of the lateral notal margins, and the presence of a distinct frontal veil.

To this third family may now be added an additional species with certain morphological features so distinctive as to depart from the orthodox concept of the Arminidae. I am deeply grateful to Mr. and Mrs. Alan Wolfson, whose collections from the Gulf of California have provided me with the opportunity of examining this interesting new species.

NUDIBRANCHIA

Arminacea

EUARMINACEA

Arminidae

Armina convolvula Lance, spec. nov.

The largest of six specimens collected measured 75 mm. in length and 32 mm. in breadth (36 mm. at the widest point between the angles of the foot) when actively crawling. The smallest individual was 44 mm. long and 19 mm. broad. The specimen (holotype) upon which this description is based was of average size and measured 60 mm. long and 25 mm. broad when alive.

The body is broadest in front and tapers very slightly to a rounded tail. The entire notum is free except for a very narrow region between the rhinophores, where it slopes forward and sharply downward to expand into a broad frontal veil with an undulating anterior margin (Figure 1). The entire surface of the notum is textured with about 20 to 25 highly convoluted ridges that originate at its anterior border and run posteriorly and somewhat obliquely from the median line. In the lateral notal regions the ridges are not entire but occur as linear series of asymmetrical papillae. At the anterior end, one to three ridges continue forward between the rhinophores and run for a short

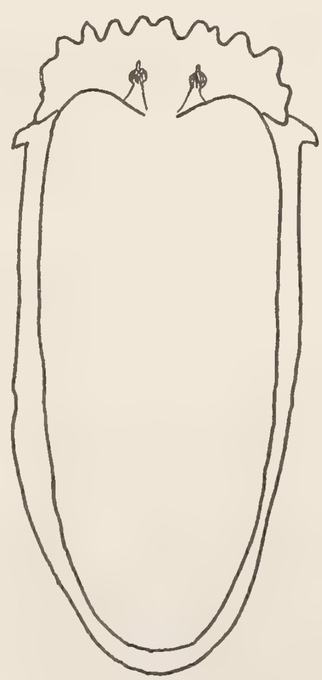

Figure 1: *Armina convolvula* Lance, spec. nov. Dorsal view of living animal.

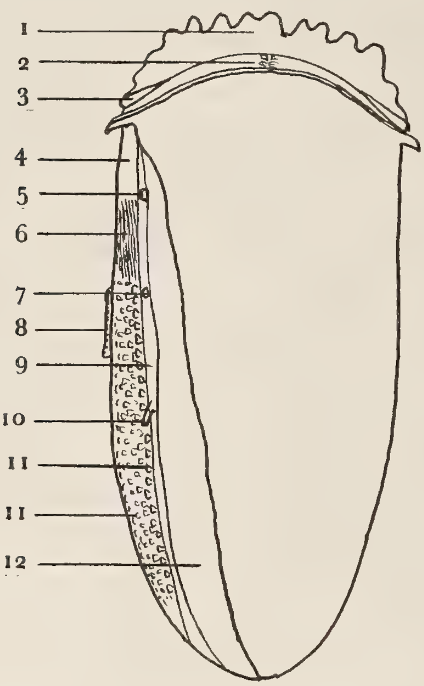

Figure 2: *Armina convolvula* LANCE, spec. nov.

Ventral view of living animal with foot rolled over to expose hyponotum.

1. dorsal fold of veil
2. mouth
3. ventral fold of veil
4. hyponotum
5. genital aperture
6. anterior branchial lamellae
7. renal pore
8. glandular lamella
9. side of body
10. anal papilla
11. posterior branchiae
12. foot

distance onto the veil. In some individuals the veil is heavily ridged, while in others only a few short ridges interspersed between irregular papillae occur. The foot is broad, very thin, and extends well beyond the lateral and slightly beyond the posterior parts of the body. It is united to the hyponotum by a vertical septum at the posterior end. Anteriorly it is weakly bilabiate, the upper lip being very thin, with lateral corners produced into acute angles (Figure 2). A ventral portion of the veil occurs as a slender, transverse flap (Figure 3), and follows the contour of the anterior margin of the foot. The mouth is situated between the flap and the upper border of the foot.

The animal is strikingly colored. The entire notum is dark chocolate brown and thickly set with small, irregular, opaque-white spots, most of which are set upon the summits of the notal ridges. Unlike most species of Armina, in which a color pattern of longitudinal stripes is displayed, this species appears to have the white markings more or less uniformly distributed over the entire notum due to the highly convoluted nature of the ridges and the uniformity of the dark background color. The foot is an intense flesh-pink with three distinct bands of color circumscribing its dorsal margin. On the outer edge a very thin white line occurs flanked by a central broad band of bright orange. Around the inner side runs a wide stripe of opalescent blue-white identical in color to that found in Hermissenda crassicornis. A thin line of the same color originates at the upper border of each rhinophore stalk, descends along its anterior border, and becomes more diffused as it proceeds obliquely to terminate at the outer posterior margin of the veil. The stalk and tips of the rhinophores are colorless, but the clavi are reddish brown. The inner surfaces of the fold of the veil are covered with minute white dots, and the hyponotum, foot, and gills are more sparsely flecked with the same. The anterior margin of the veil is orange. No variations in color pattern occurred between the largest and smallest specimens.

The longitudinally directed anterior branchial lamellae are located on the under surfaces of the lateral notal margins, about one-third of the way back, and consist of about 20 longer lamellae alternating with an equal number of shorter ones (Figure 4a). In different individuals, one, two, or three of these anterior lamellae

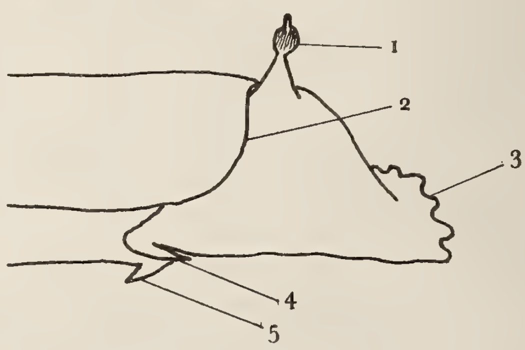

Figure 3: *Armina convolvula* LANCE, spec. nov.

Antero-lateral view of living animal.

1. rhinophore
2. anterior edge of notum
3. dorsal fold of veil
4. ventral fold of veil
5. foot angle

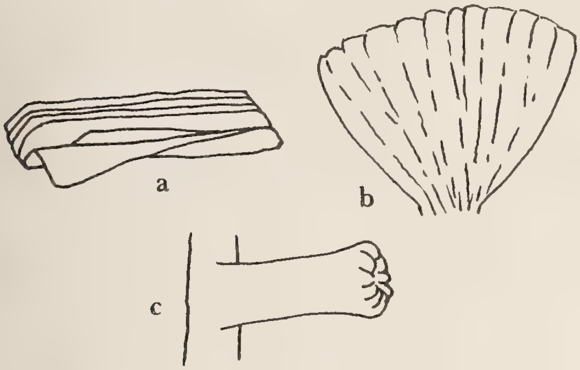

Figure 4: *Armina convolvula* LANCE, spec. nov.

a. anterior branchial lamellae with one gill folded over to expose smaller alternating gill.
b. posterior gill.
c. anal papilla.

extend back into the structurally differentiated posterior branchiae (Figure 4b). These latter gills are fan-shaped, arranged in four or five irregular rows running back nearly to the posterior septum, and attached to the subepidermal digestive diverticulae. The smallest are located nearest the notal margins, becoming increasingly larger more medianly where the major branches of the digestive diverticulae emerge. A total of 86 were counted on one side in an individual 58 mm. in length.

The rhinophores are 4.4 mm. in height and highly contractile but not retractile within a common subepidermal chamber. They may, however, be completely withdrawn below the level of the notum into temporary individual chambers formed by the stalks rolling outside-in. Such is the case in preserved specimens. At its base the stalk is wider than the clavus but rapidly tapers to a slender neck. The clavus is nearly vertically perfoliate with 12 to 18 leaves more or less joined along the anterior margin, and tipped with an elongated, slender papilla.

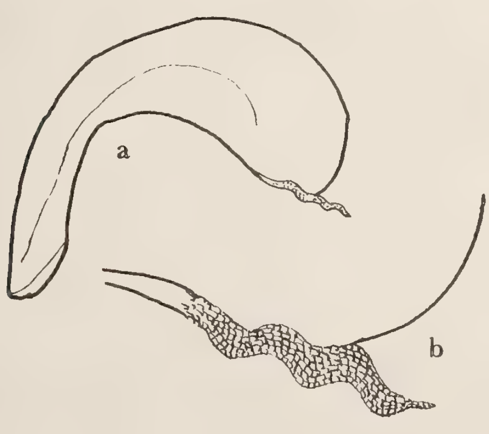

Figure 5: *Armina convolvula* LANCE, spec. nov.

a. outer view of jaw plate.
b. detail of scales of masticatory process.

The genital aperture is on the right side of the body just anterior to and below the first branchial lamellae. Slightly over halfway back, on the same side of the body, is located an elongated anal papilla bearing a group of terminal lobes (Figure 4c). The renal pore is on a line halfway between these two apertures.

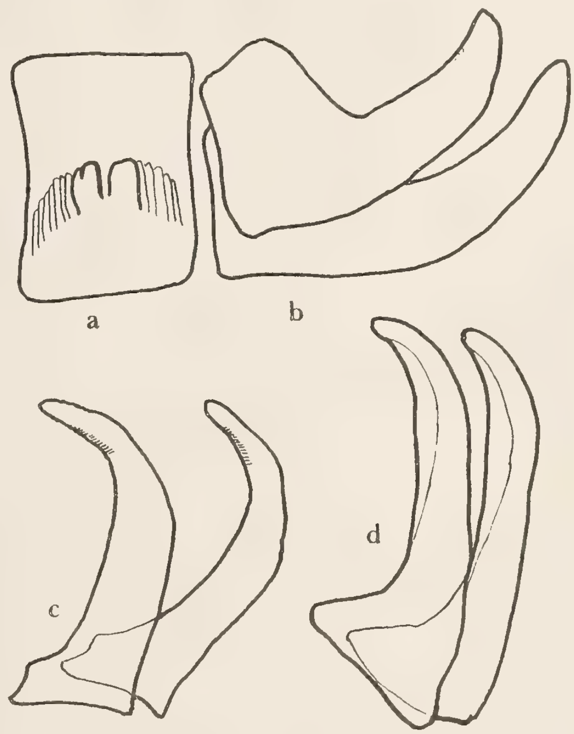

Figure 6: *Armina convolvula* LANCE, spec. nov.

Radular Teeth

a. central tooth, x 320
b. first two laterals, x 320
c. two central laterals, x 128
d. two outermost laterals, x 320

In addition to the two types of branchial lamellae, a thick, white, glandular lamella, attached close to the edge of the hyponotum, occurs about halfway back on either side.

The slender jaws are 9 mm. in length, highly arched, and a deep horn color (Figure 5a). The weak masticatory process bears a thickened, slightly undulating margin covered with several rows of scales (Figure 5b). The radula measured 5.1 mm. in length and 4.8 mm. broad and contained 40 rows of teeth in the combination 88:1:88. Central elements consisting of large, elongated, rectangular basal plates bearing cusps with five to nine denticles on ei-

ther side occurred in three specimens examined (Figure 6a). Unlike other species of Armina, the cusp does not bear a single, strong, terminal denticle, but two, relatively broad, blunt, median ones. Although the hook of the first lateral is shorter and broader, it is not differentiated from the rest (Figure 6b). The central laterals bear a highly variable number of minute denticles (usually 10 to 18) toward the tip (Figure 6c). The outermost laterals rapidly decrease in size and have smooth borders (Figure 6d). Descriptions of the jaws and radula are from paratypes in order to retain the holotype intact.

Type Locality & Range

Approximately 15 miles south of San Felipe, Mexico, on the eastern shore of Baja California. Latitude 30° 48' N., Longitude 114° 42' W. All specimens were collected in a rocky association at the lower edge of the intertidal area during a minus tide. When placed on a sandy substrate in an aquarium, a tendency to burrow was observed.

The specific name convolvula was chosen to call attention to the highly convoluted ridges on the notum.

The holotype is deposited at the California Academy of Sciences where it is registered as Paleontology Type Collection No. 12 402; it will be incorporated into the Frank Mace MacFarland Memorial Collection of Nudibranchs.

REMARKS

Three species of Armina have been described from the Pacific Coast of North America since Cooper's original description of A. californica (1862). His observations on numerous individuals from San Diego Bay, while typically lacking in detail, were adequate at that time to distinguish the species he was describing. In the ensuing hundred years Bergh (1876) proposed A. vancouverensis, O'Donoghue (1924) described A. columbiana, and Pruvot-Fol (1955) separated A. digueti, all from Cooper's species and from each other on the basis of minor morphological variations which appear to be highly inconsistent.

Marcus (1961) obtained two specimens of Armina from Tomales Bay, California, assigned one to A. columbiana and the other to A. californica, and suggested that the possession of nuchal papillae by the former was a distinguishing characteristic. The remaining species have been separated on the basis of variations in the radula and disposition of the notal ridges and related patterns of pigmentation. It is improbable that characters of such small magnitude will justify retaining all four as distinct species, but this can only be determined when series from separate geographical areas have been compared.

The propriety of including the present species in the family Arminidae, according to the concepts of Odhner (1939), is questionable because of the absence of both a common rhinophoral chamber and an entirely free notal margin. However, the figures for Armina japonica (Baba, 1949) clearly indicate an inter-rhinophoral continuity between the notum and the veil.

The present species possesses other distinguishing characteristics of the Arminidae, viz., a similar radula, two types of branchial lamellae on the underside of the notum, a renal pore situated between the anterior genital aperture and posterior anus on the right side of the body, a well developed anterior veil, and a longitudinally ridged notum free of appendages. These morphological features, in combination with a behavioral tendency to burrow in sandy substrates, indicate a close affinity to the Arminidae.

In view of the highly polymorphic nature of the Arminacea, the dearth of species so far ascribed to this suborder, and our near total lack of knowledge of the Panamic opisthobranch fauna belonging to this group, I postpone the question of creating a higher monospecific taxon and suggest the inclusion of this species for the present time in the genus Armina.

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Notes & News

Notes on the Nomenclature of Certain Mitrid Species

BY

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It has come to my attention that a few unintentional errors or omissions have appeared in papers I have published in this journal during the past year. I wish to correct them or comment on them, as follows.

1. 1960. The Veliger, 3(2): 49. For Mitra nigra (Schröter, 1788), read Mitra nigra (Gmelin, 1791). A note regarding this correction has been published by R. T. Abbott (The Veliger, 4(4): 213).

2. 1961. The Veliger, 4(1): 4-8; ibid., 4(2): 76-85. For each citation of Vexillum regina (Sowerby, 1825), read Vexillum regina (Sowerby, 1828). This part of Sowerby's Genera of Shells was actually published three years after the date printed on the flyleaf of the first part. He did cite V. regina in 1825 in the Tankerville Catalogue, but this is a nomen nudum.

3. I have been reminded that Vexillum taeniatum (Lamarck, 1811) has supposedly been replaced by V. ornatum (Link, 1807) on the basis of a note by Tomlin in the Nautilus (1920, Nautilus, 33: 134). Tomlin's statement follows:

"Voluta ornata Link. No fig. quoted, but I do not think that there can be any doubt that the description is a clear and accurate one of taeniata Lamarck as now understood. Mitra ornata will therefore supersede M. taeniata."

For several reasons I did not attempt in my papers (1961, op. cit.) to include complete synonymies for the various species discussed; hence, it seemed unnecessary to refer to the Tomlin notice. It is my opinion that Link's rather vague discussion of Voluta ornata (1807, Beschreibung der Naturalien-Sammlung der Universität zu Rostock, p. 128) does not constitute a valid species description according to the rules of the International Commission of Zoological Nomenclature, and that Tomlin's statement, therefore, may be disregarded. Although a good figure of Vexillum taeniatum appears in the Encyclopédie Méthodique (1797, Pl. 373, Figs. 7a, 7b) that could presumably have been cited as an illustration, Link made no reference to any figure, as Tomlin pointed out. Lacking such a reference, Link's description could apply to any of several mitrid species, of which the six discussed in J. Cate (1961, op. cit.) are only a few.

A literal translation of Link's description (for which I am indebted to Dr. Rudolf Stohler) says only this: "V. ornata. Similar to the preceding one, ["V. elegans (= V. plicaria$_{\beta}$") J. C.] but less striped, and the base not recurved. Each whorl is yellow above, then follows a brown band and the lower portion is white; close to the base the yellow fields and brown bands alternate." It would be difficult to prove that Vexillum taeniatum (Lamarck) was the species Link meant by this sketchy description and not V. vittatum (Swainson) or V. compressum (Sowerby), to mention only two possibilities. I consider V. taeniatum (Lamarck, 1811) the first name validly applied to the species in question, until more conclusive proof can be found that this name should be superseded by any other.

A Range Extension for Two Species of Hawaiian Terebridae (Gastropoda)

BY

R. D. BURCH

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Hastula lauta (Pease, 1869)

Through the courtesy of Dr. Arthur H. Clarke, Jr., Malacologist, National Museum of Canada, I recently had the opportunity to examine a large number of Terebridae taken by divers in waters of six to ten feet off Alabat Island, Philippines (Latitude 14° 20' N., Longitude 122° 0' E.). These specimens were collected by the Norton Expedition, 1959, and donated to the Museum by one of the expedition members, Mr. Pedro de Mesa, Quezon City, Philippine Islands. These specimens bear the National Museum of Canada catalogue number 12 002.

This material included a number of Terebridae species recorded as indigenous in various areas of the Indo-Pacific; however, the following among them have been recorded from Hawaii: Terebra columellaris Hinds, 1843; T.

babylonia Lamarck, 1822; T. chlorata Lamarck, 1822; T. plumbea Quoy & Gaimard, 1832; T. affinis Gray, 1834; T. funiculata Hinds, 1843; Hastula verreauxi (Deshayes, 1857); H. casta (Hinds, 1843); and H. lauta (Pease, 1869).

Recent references have recorded Hastula lauta as a species endemic to Hawaii and have reported the habitat to be deep water.

Mrs. Elizabeth Harrison of Honolulu and Mr. and Mrs. Crawford N. Cate of Los Angeles have generously loaned a large number of specimens of Hastula lauta taken from several Hawaiian localities, and comparison of these with the Alabat Island specimens shows them to be identical. The Hawaiian specimens display a range of color forms not duplicated in variety by the Alabat Island shells; however, the color is identical in many individual specimens. Unless marked, mixed specimens from the two areas cannot be separated; color-pattern, size, apical angle, sculpture, rib-count, and other pertinent characteristics being compatible. According to collection data accompanying specimens of H. lauta in both the Harrison and Cate collections, it has been taken alive at depths ranging between 6 and 100 feet.

Hastula lauta can be expected to occur westward from Hawaii to Alabat Island in the Philippines. This major range extension (in degrees Longitude) of the species has been accomplished while maintaining a relatively narrow range in Latitude (less than 7°).

Additional specimens of Hastula lauta collected off Alabat Island can also be found in the collections of Mr. J. E. Norton and Mr. Pedro de Mesa of the Philippines and in the Burch collection of Terebridae.

A number of Hastula species have a superficial resemblance to H. lauta, and a series of each of the following Indo-Pacific species has been considered as comparison material: H. diversa (E. A. Smith, 1901); H. lepida (Hinds, 1843); H. verreauxi (Deshayes, 1857); H. mera (Hinds, 1843); and H. strigillata (Linnaeus, 1787).

Terebra contigua Pease, 1871

The generosity of Mr. W. C. DeWitt of Freeport, Texas, has recently made available to me a number of Terebra specimens which had been collected at Canton Island in the Phoenix Island Group, rounded to the nearest degree as Lat. 3° South, Long. 172° West. These were a part of the collection made at that island by Mr. Raymond C. Naumann of Angleton, Texas; during March through August, 1942. Mr. Naumann has since furnished additional collection data for these specimens which show them to have been littoral or dredged off the east and south beaches of Canton Island.

Of the three Terebra species collected by Mr. Naumann at Canton Island, all have been recorded from Hawaii as follows: T. dimidiata (Linnaeus, 1758), one specimen, an albino of this species dredged on the south side of the island; T. cancellata Quoy & Gaimard, 1833, two specimens littoral on the east beach; T. contigua Pease, 1871, three specimens littoral on the east and south beaches.

Terebra contigua has been recorded as a species endemic to Hawaii where it is considered as rare; however, it can be expected to occur southward and westward from Hawaii to Canton Island.

Terebra contigua is a very distinctive species, difficult to confuse with others of the small Terebras; however, several species have some superficial resemblance to it. Series of a number of Indo-Pacific species in my collection have been compared in establishing this identification and range extension; among these are the following which have been recorded from Hawaii: T. plumbea Quoy & Gaimard, 1832; T. nitida Hinds, 1843; T. clappi Pilsbry, 1920; and T. rosacea Pease, 1869.

Acknowledgment

I wish to express my thanks to Dr. Clarke for having provided his Alabat Island specimens and for his permission to cite them. The interest and generous assistance of Elizabeth Harrison and Crawford and Jean Cate in loaning their collections of Hawaiian Terebridae is acknowledged with gratitude. Mr. de Mesa's original contribution of specimens and his subsequent kindness in confirming the collection data is very much appreciated. My friend, Bill DeWitt, has been of great assistance with the Canton Island specimens, as well as with other species cited here; while Mr. Naumann has been patient with his time and generous with specimens from his collections.

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1960. Provisional check list of gastropods recorded from the Hawaiian chain, Terebra. 8 (4): 8; and 8 (5): 8.

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Destroyed Type Material

BY

GALE G. SPHON, JR.

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Santa Barbara, California

On April 12, 1962, the Ornithology-Mammalogy and the Entomology-Conchology laboratories and collections of the Santa Barbara Museum of Natural History were destroyed by fire. The former was completely destroyed and very serious damage was done to the latter. Among the things lost in the Invertebrate Department was the small, but rapidly growing, collection of molluscan type material. Even though there were no holotypes involved, it is felt by all involved that the complete loss of our paratypes and hypotypes should be reported.

The following list includes my own type material which was at the Museum and was also lost in the fire.

PARATYPES

Acanthina tyrianthina Berry (1 SBMNH; 1 Sphon)
Ariela mitriformis Shasky (2 Sphon)
Berthelinia belvederica Keen & Smith (3 SBMNH)
Chione picta Willett (figured paratype) (1 SBMNH)
Clathrodrillia bicarinata Shasky (2 Sphon)
Crassispira nymphia Pilsbry & Lowe (2 SBMNH)
Ischnochiton catalinae Willett (1 SBMNH)
Lamellaria sharoni Willett (1 SBMNH)
Lithophaga attenuata rogersi Berry (1 Sphon)
Melanella randolphi Vanatta (2 SBMNH)
Mitra directa Berry (1 Sphon)
Nassarius howardae Chace (1 SBMNH; 1 Sphon)
Ocenebra keenae Bormann (1 SBMNH)
Pseudomelatoma (Burchia) redondoensis Burch (1 SBMNH)
Trivia elsiae Howard & Sphon (1 SBMNH; 1 Sphon)
Turritella anactor Berry (1 SBMNH)

HYPOTYPES

Cancellaria obesa Sowerby (1 Sphon) cited by Shasky, The Veliger, 4(1), 1961
Crassispira grandimaculata (C. B. Adams, 1852) (1 Sphon) cited by Sphon, The Veliger, 3(1), 1960
Crassispira pluto Pilsbry & Lowe (? SBMNH) cited by McLean, Trans. San Diego Soc. Nat. Hist., 12(28), 1961
Iselica ovoidea Gould (? SBMNH) cited by McLean, Trans. San Diego Soc. Nat. Hist., 12(28), 1961
Macrarene coronadensis Stohler (1 SBMNH) hypotype no. 16 cited by Stohler, Proc. Calif. Acad. Sci., 29(11), 1959
Mitra erythrogramma Tomlin (1 Sphon) cited by Sphon, The Veliger, 3(1), 1960
Mitra fultoni E. A. Smith (1 Sphon) figured by Sphon, The Veliger, 4(1), 1961.
Trivia californiana (Sowerby) (? SBMNH) cited by McLean, Trans. San Diego Soc. Nat. Hist., 12(28), 1961
Trivia solandri (Sowerby) (? SBMNH) cited by McLean, Trans. San Diego Soc. Nat. Hist., 12(28), 1961
Truncatella bairdiana C. B. Adams (? SBMNH) cited by McLean, Trans. San Diego Soc. Nat. Hist., 12(28), 1961
Typhis lowei Pilsbry (1 Sphon) cited by Shasky, The Veliger, 4(1), 1961

A Correction

BY

ALLYN G. SMITH

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I am indebted to Dr. H. B. Baker for calling attention to an oversight in my article "The Type Species of Lepidopleurus Leach in Risso, 1826", which appeared in The Veliger, vol. 2, no. 4, pp. 75-77, April 1, 1960. In this (p. 75, col. 1, line 5) the selection of Chiton cajetanus as the type species was attributed to J. E. Gray, 1847. As Dr. Baker correctly points out, A. N. Herrmannsen in "Indicis Generum Malacozoorum Primordia. . .", vol. 1, p. 582, designated the same species as type with a publication date of May 25, 1847. This has precedence over Gray's selection, which was published in November of the same year. While this is of relatively minor significance, in the interest of accuracy, it is suggested that "Herrmannsen" be substituted for "J. E. Gray" on page 75. Also, for completeness, Herrmannsen's work should be added to the list of selected references as it is a most important one in taxonomic work on the mollusks.

Literature Cited

Smith, Allyn G.
1960. The type species of Lepidopleurus Leach in Risso, 1826. The Veliger 2 (4): 75-77; pl. 17.

Covers for Volume 4

have been prepared, exactly like those for volume 3. Due to Postal Regulations we are unable to include a copy with the current number. Those of our subscribers who wish to obtain a copy may do so by sending 25 cents to Mrs. Balch, 1150 Brown Avenue, Lafayette, California. We estimate that this will cover the actual cost of packing and mailing. Please, do not send postage stamps in payment.

The same postal regulations made it necessary for us to bind the index and front cover into the last issue of volume 4.

Information Desk

What's the Difference?

Topotype - Homeotype - Plastotype
Lectotype - Neotype

BY

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Secondary types include the topotype, homeotype, plastotype, lectotype, and neotype. The sequence in which we listed these is not necessarily in the order of their respective importance. We chose this arrangement rather because the first of these types need little explaining beyond their definition.

We designate as topotypes any specimens that come from the type locality, obtained at any time other than when the holotype was collected. Of course, in order to be a true topotype the specimen must come from the actual type locality. By this we mean that if the type locality was originally designated as "Pacific Ocean" not every specimen of that species collected anywhere in the Pacific Ocean is a topotype. If the original type locality designation was proper, then we should know a very narrowly circumscribed area, possibly a small ravine or a large rock, exactly identified and identifiable. And then all subsequently found specimens from that ravine or that rock will be topotypes.

A homeotype is a specimen of a particular species that was compared by a very competent observer with the primary type material, be it the holotype and paratypes, or with the syntypes (and the older cotypes). Of course, the term implies not merely that a specimen was compared with the primary type but also that it was found to agree in every important detail. Other terms have been used for this kind of material, such as comparotype, but such terms are not desirable and the word homeotype is the officially accepted one.

The plastotype is a three-dimensional reproduction of the primary type. This is often resorted to in the case of petrefactions where frequently plaster casts are relatively easily made. However, with the modern techniques of latex rubber reproductions, more complex types can be reproduced faithfully. For the time being such material is expensive, but it may be anticipated that the day will come when the technique has been so developed that reproductions of the actual type specimens will be relatively inexpensive and then such plastotypes may be sent for examination to qualified workers. Today we can often obtain good photographs of primary types from the responsible repositories. However, even the best photograph does not completely take the place of the actual specimen. And even stereoscopic color photographs leave something — though admittedly not much — to be desired.

Of greater importance than the three types already discussed are the lectotype and the neotype. If the original author failed to designate a particular specimen as the holotype (and, of course, assuming that the type lot contains more than just one specimen), then it is the privilege of the first competent reviewer of the group concerned to select one particular specimen from among the syntypes (or cotypes, as the case may be) and designate that specimen as the lectotype. This then becomes equivalent to the holotype. Of course, the reviewer will exercise the best judgment, carefully comparing every specimen in the lot with the original description and endeavoring to ascertain which particular specimen the original author would most probably have designated as the holotype, had he really done so. If the first reviewer of the group does not exercise this prerogative, then any subsequent reviewer has the same privilege. But once a lectotype has been selected, there can be no further change. The lectotype has then become just as important as the primary type. In fact, it can be considered as a primary type since it came from the original type material. It is unnecessary to stress that the lectotype should be preserved as carefully as the

holotype should be.

It is desirable that the primary type material be preserved with the greatest of care, protected against loss by any conceivable means — theft, fire, explosion, etc. This is one reason why the original author should select as repository for his holotypes an institution which can guarantee the utmost in protection and why it gives me cold shivers to think of some type material retained by the original authors during their lifetimes. No matter how careful a person may be, as long as he lives in a private residence his house may burn to the ground and everything contained therein may be completely destroyed. But not only private residences are subject to destruction. Public museums can be destroyed by fire and earthquake; collections may be looted by ignorant — or not so ignorant — military personnel in overrun countries during war times. In short, in spite of the greatest care, it is still possible that the original type material may become lost. If the author had available a number of paratypes and had these distributed widely or at least as widely as possible, then one of the paratypes may be selected as a lectotype. There are, however, also very valid reasons for an entire type lot, including many paratypes, to be kept together. In any event, if the original type lot is lost through accident or misdeed, then it may become necessary, in order to avoid confusion, to select a specimen of the particular species and to designate it as neotype. This is, however, a very serious step and one not to be taken lightly. In fact, the International Commission on Zoological Nomenclature has established rules which are much more stringent than those applicable to describing a new taxon. Among these rules we mention: the person selecting a neotype must first establish beyond a reasonable doubt that the original type material is completely destroyed or lost beyond hope of recovery (this holds true especially with type material of early authors; such type specimens were often sold and frequently replaced in collections with "better" specimens); the selection or an adequate reference to the selection must be published in the Bulletin of Zoological Nomenclature; the newly established type (neotype) must be described as accurately as possible and deposited in a recognized repository, just as a holotype must be deposited; the author also must furnish adequate evidence that his identification is correct. Within five years after such publication in the Bulletin other workers may challenge this selection if in their opinion it was unwise or incorrect. In such a case the International Commission will probably review all the evidence and make a final decision.

Books, Periodicals, Pamphlets

FOSSILS: AN INTRODUCTION TO PREHISTORIC LIFE

by William H. Matthew, III

Barnes & Noble, New York. Pp. xii + 337, 180 figures in text. $2.25. [Also available in cloth, $5.75]

This book fills a long-felt need for a clearly written guide that one can recommend to laymen and beginning students of paleontology. It covers, briefly yet concisely, all the background information needed to start the study of fossils: how they are formed, what uses they serve in scientific work, how to collect and identify them, and how to arrange the collection. In addition there are chapters that give a sketch of Earth's history, the history of paleontology, the history of man — eleven chapters in all. Five appendices provide useful supplementary information: the main divisions of the organic world, a glossary of terms, a list of publications, a condensed list of geological information centers of the United States, and a partial list of museums displaying fossils.

Author and publishers are to be congratulated on the appearance of the book. The illustrations, most of which are culled from previous literature, are well chosen and make the work useful not only to the layman but also to the professional. In a compendium of such broad coverage, some misstatements are to be expected. The number here seems to be unusually low, which augurs well for the usefulness of this book. Two minor errors were noted: the text states (p. 219) that the beak in the pelecypod is "commonly located on the anterior (front) end of the shell", but fortunately Figure 110 correctly shows it as part of the dorsal margin; also (p. 184), pelecypods do not range from Early Cambrian time, for the first that are unquestionable are from latest Cambrian or Early Ordovician strata. These, however, are minor defects in a book that can be recommended as a good introduction to paleontology.

MK

PROCEEDINGS OF THE MALACOLOGICAL SOCIETY OF LONDON

Vol. 34, Pt. 6. December 1961.

"Size and sex in Cypraeidae" by R. J. Griffiths.

MK

COMMON SEASHORE LIFE OF SOUTHERN CALIFORNIA

by Joel Hedgpeth and Sam Hinton

Naturegraph Company, Healdsburg, California. Pp. 65, 10 color illustrations, 160 textfigs. 1961. Cloth, $3.25; paper, $1.75.

If you are an amateur naturalist or a serious student of shore life and are fortunate enough to be studying or holidaying along the southern California coast, you will find this compact and elucidating manual an invaluable guide for identifying the more common seashore animals and marine plants living from Point Conception to the Mexican border. The introduction gives a brief outline of the geography and the climatic and tidal conditions, particularly in the La Jolla area (with map).

The text by Joel W. Hedgpeth, Director of the University of the Pacific's Marine Station of Biological Science at Dillon Beach, graphically describes the flora and fauna by life zones in typical locales. Excellent black-and-white illustrations, though some mislabeled, are by Sam Hinton, Science Director of the Museum-Aquarium of the Scripps Institution of Oceanography, who has also written the section on the birds.

The last half of the guide provides a valuable systematic list in the form of a simple synoptic key of the common and most spectacular seaweeds and animals by Vinson Brown, illustrated by Carol Lyness. This includes many organisms not covered in the more detailed descriptions, which will help beginning collectors and students in naming their specimens. While emphasis throughout the book is on animals, enough attention is given to marine algae and to various ecological factors for the reader to understand the natural relationships of seashore life. The key provides further understanding by outlining the relationships between and within the broad groups of marine life in an easily understood style. The authors have included a list of 12 suggested references for a more detailed study. The index is based primarily on common names.

Although the manual deals specifically with the life along the coastal waters of southern California, enough of the plants and animals described are found also in waters to the north to make it useful to students of the seashore along the coast of central and northern California.

Mary Jo Ryan
San Francisco State College

CONTRIBUIÇÃO Á PALEONTOLOGIA DO ESTADO DO PARÁ.

Revisaõ da Família Pectinidae
da Formaçao Pirabas (Mioceno Inferior)
com a descripção de novas espécies.
VI — MOLLUSCA — PELECYPODA

by C. S. Ferreira

Arquivos do Museu Nacional (Rio de Janeiro), vol. 50, pp. 135 - 165, 4 pls. December 31, 1960.

This work contains descriptions, discussions, keys, and illustrations of 12 species (two doubtfully identified) from the Pirabas formation in Brazil considered to be of early Miocene age. The species are placed in two genera, Amusium with one species, and Chlamys with the remainder which are arranged under Chlamys, Argopecten, and Leptopecten. The following are described as new: Chlamys japericensis, n. sp., C. (Argopecten) tetristriata, n. sp., C. (A.) coopericellus, n. sp., C. (A.) capanemensis, n. sp., and C. (Leptopecten) pirabensis, n. sp.

Of special interest to West American workers is the form cited as "Chlamys (Leptopecten) cf. latiaurata (Conrad, 1837)". Conrad's species has not been reported occurring before Pliocene time in the eastern Pacific. Judging from the illustrations only, the Brazilian form resembles some species of Leptopecten described from the late Cenozoic of the Caribbean region more closely than it does the West American species.

LGH

BRAIN AND BEHAVIOR IN CEPHALOPODS

by M. J. Wells

Stanford University Press, Stanford, California. Illustrated. June 1962. About $4.50.

A detailed description of the structure and behavior of the class of mollusks that includes octopuses, squids, and cuttlefish, with emphasis on nervous organization.

JQB

SEA SHELLS OF THE WORLD

by R. Tucker Abbott
in consultation with Herbert S. Zim

Illustrations by George and Marina Sandstrom. A Golden Nature Guide, Golden Press, New York. 160 pp., 790 figs. in color. 1962. \$1.- (limpbound); \$3.50 (library edition).

There has long been a need for a guide to the commoner shells of the world, which now is met by a book of handy size. The color illustrations are large enough for use in identifying, the descriptions are short but adequate, and the selection is satisfactory. An introductory section gives the fundamentals on distribution, classification, and organization of mollusks. Indications of size are included for each form, and grouping within family categories shows geographic occurrence. Formal systematic terms are kept to a minimum; however, scientific names for each species are given, with name of author (but not date). Parentheses for authors' names are omitted, and common names (mostly coined from the scientific name) are given primary place in boldface type, ahead of the scientific name.

Proofreading and attention to detail seem to have been done with care; one small oversight on page 72 is the attributing of Murex regius Swainson, 1821, and M. brassica Lamarck, 1822, both to Gmelin (1791).

This is a book that one can recommend with confidence to laymen, and even the professional workers will find it convenient for reference.

MK

BETWEEN PACIFIC TIDES

by Edward F. Ricketts and Jack Calvin

Third edition, revised by Joel W. Hedgpeth. Stanford University Press, Stanford, California. May 1962. \$8.75.

Includes a new chapter on marine ecology and a revised bibliography. Contains 105 pages of photographs and drawings.

JQB

NEW LAND MOLLUSKS FROM MADAGASCAR AND MEXICO

by Fritz Haas, Curator Emeritus
Chicago Natural History Museum

Fieldiana-Zoology, vol. 44, no. 3, pp. 19-23, figs. 10-12. November 15, 1961.

A short taxonomic paper describing a new genus and three new species of land snails, as follows:

Malarina, n. gen. of the Cyclophoracea
Malarina hova, n. sp. from Madagascar
Bulimulus (Rhabdotus) fonsecanus, n. sp. from the Gulf of Fonseca, San Salvador (or Nicaragua)
Polygyra (Erymodon) hertleini, n. sp. from Tenacatita Bay, Jalisco, Mexico.

Each of these three species is illustrated with excellent black-and-white photographs of the type specimens.

AGS

QUEENSLAND AND GREAT BARRIER REEF SHELLS

by O. H. Rippingale and D. F. McMichael

The Jacaranda Press Pty., Ltd. Pp. 216 (each page $8\frac{3}{4} \times 11\frac{1}{4}$ inches), 29 color plates (each plate $10 \times 7\frac{1}{2}$ inches). 1961. \$17.00 (also available is a limited number, deluxe edition signed by the authors, numbered, in special binding and slip case for \$28.00).

Mr. Rippingale is a talented water-colorist as well as being a conchologist of considerable repute, and Dr. McMichael is Curator of Shells at the Australian Museum in Sydney. The 29 color plates illustrate about 600 species. Shells are arranged in their classes and families, each is fully described with details of shape, color, size, and habitat in the text accompanying each plate.

JQB

SOUTH AUSTRALIAN MOLLUSCA, PELECYPODA

by Bernard C. Cotton
Curator of Mollusks
South Australian Museum

Australian Government Printer, Melbourne. Pp. 363, 350 textfigs. 1961. 24s, 6d (about $5.00).

This book replaces the preliminary work published in 1938 and long out of print. It includes all references, lists of localities, and general information on all species. The species are fully described and figured so that with the help of keys, the 334 species may be readily determined. The figures are clear, and the keys to both genera and species are of great value to the student of other faunas.

JQB

VENUS: THE JAPANESE JOURNAL OF MALACOLOGY

Vol. 21, No. 4. December 1961.

"The shells and radulae in *Berthelinia*, a bivalved Sacoglossan genus" by Kikutarô Baba.

"Cytotaxonomy of the Euthyneuran gastropods" by Akihiko Inaba.

"On the Family Triphoridae (Gastropoda) from Amami Islands (2)" by Sadao Kosuge.

"Descriptions of fifteen new species of Japanese shells" by Tadashige Habe.

"Description of four new cancellariid species, with a list of the Japanese species of the Family Cancellariidae" by Tadashige Habe.

"Biogeographical notes on Japanese Terebridae" by Katura Oyama.

"On *Mikadotrochus salmiana* found off Chôshi, East Japan" by Tokio Shikama [Family Pleurotomariidae].

"Note on a second occurrence of *Erosaria guttata* in Japan" by Tokio Shikama.

"On the breeding of *Cantharidus callichroa jessoensis* (Schrenck)" by Yoshio Kojima [Family Trochidae].

MK

BRITISH SLUGS
(Pulmonata: Testacellidae; Arionidae, Limacidae)

by H. E. Quick

Bulletin of the British Museum (Natural History, Zoology), vol. 6, no. 3, pp. 105-226, pls. 1-2, figs. 1-19, 23 distributional maps. London. March 1960. 45 shillings.

An excellent, up-to-date, comprehensive work on the slugs of Great Britain, the first since J. W. Taylor's classic monograph of the land and freshwater mollusca of the British Isles, published 1902-07. For anyone interested in slugs as garden pests or otherwise, this work is a necessity. American students will need it as a reference because of the many British species that have been introduced into California and elsewhere in the United States. The monochrome drawings of various species illustrated in the plates are helpful.

AGS

Received Too Late for Review in This Issue:

THE GENUS TUBUAIA PULMONATA, ACHATINELLIDAE

by Yoshio Kondo

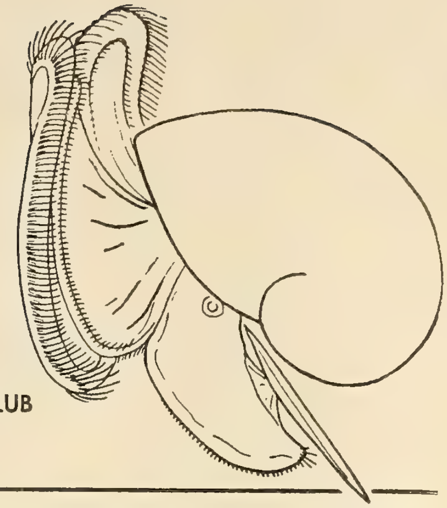
Bulletin 224, Bernice P. Bishop Museum, Honolulu 17, Hawaii. 1962. $1.50.

THE BATHYAL AND ABYSSAL XYLOPHAGA (PHOLADIDAE, BIVALVIA)

by Jørgen Knudsen

Galathea Report, vol. 5. Danish Science Press, Ltd., Copenhagen, Denmark. 1961. 20 Danish Kroner.

THE VELIGER



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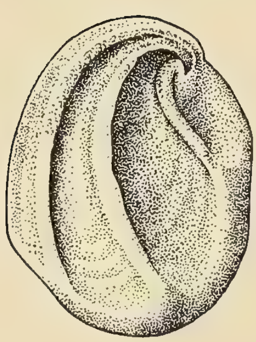

Note: The various taxa above species are indicated by the use of different type styles as shown by the following examples:

ORDER, Suborder, **DIVISION, Subdivision,** SECTION, SUPERFAMILY, FAMILY, Subfamily, *Genus*, (*Subgenus*).

The Drilling Habit of *Capulus danieli* (Crosse) (Mollusca : Gastropoda)

BY

VIRGINIA ORR

Academy of Natural Sciences of Philadelphia, Philadelphia 3, Pennsylvania

(Plate 7; 5 Textfigures)

In 1858, Crosse described Pileopsis danieli, a new species from the littoral waters of New Caledonia. In later pages of the same journal, he called it Capulus danieli and compared it with the well-known European Capulus ungaricus (Linnaeus). {Dall, 1889, p. 287, thought Capulus danieli was "almost certainly" Patella calyptra Martyn, 1784. However, the name is not available (Opinion 456, Int. Comm. Zool. Nomenclature) and the species came from the northwest coast of America.} Capulus danieli is smaller and higher than its cap-shaped European counterpart and its thin shell is a redder brown. The shining, white interior of the shell is usually flushed with rich reddish spots. The inherent sculpture is fine radial striae but the sedentary habit of much of its adult life induces the growth of gross, flexuous, radial ribs which correspond to those of its substrate, a common New Caledonian pecten, Comptopallium vexillum (Reeve, 1853). Capulus danieli is probably a protandric hermaphrodite like C. ungaricus.

While on a Natural Science Foundation - Academy of Natural Sciences Expedition, December and January, 1960-61, Mr. and Mrs. George F. Kline and the author, with the able help of Mr. Louis Devanbez of the South Pacific Commission, Noumea, dredged several examples of this uncommon Capulus from shallow water near Noumea, New Caledonia. Additional specimens were generously given to the Academy by Mr. and Mrs. André Lepelerie, of Noumea, who dredged the shells from the same area in April, 1959. In every case but one, Capulus danieli had bored a hole through the valve and mantle of its living "host", Comptopallium vexillum. Data on these specimens are summarized in Table 1.

Other members of the family Capulidae run the gamut from independent, ciliary feeders (some Capulus) to true parasites (Thyca). A wide variety of feeding habits may be observed within a single species. Capulus ungaricus, for instance, may attach to a dead shell or stone and spend its sedentary life filtering food from water drawn in by its own efficient ctenidium. Or, it may attach to the anterior-half margin of Chlamys opercularis (Linnaeus) where it benefits from the strong inhalant current set up by the scallop's larger gills. Sharman (1956, pp. 446-449) saw individuals of C. ungaricus notch the edge of the pecten valve by removing a piece of shell with the radula. On four occasions the proboscis was extended over the notched edge of the valve to pick food particles from between the margins of the pecten's velum. This tendency toward antagonistic symbiosis is furthered by the shell-boring and food-piracy habits of C. danieli.

The positions of drill-holes of Capulus danieli and of presumed capulid scars on their pecten "hosts" are illustrated in textfigure 1.

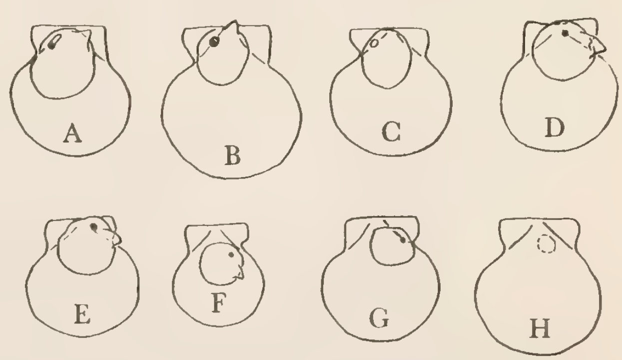

Figure 1: Diagrams of positions of *Capulus danieli* (Crosse) and their drill-holes on *Comptopallium vexillum* (Reeve). Specimens A to C and H on left valves, D to G on right valves. Letters correspond to those in Table 1. (x 0.2)

Table 1

(measurements in millimeters)

	Capulus danieli (CROSSE)				*Comptopallium vexillum* (REEVE)			
Specimen	Station	Length	Height	Sex	Length[1]	Valve	Hole Diam.	Position
A	K 511	23.5	11.5	♀	42.0	Left	1.6	Anterior
B	K 511	18.8	9.5	♀	49.6	Left	1.9	Anterior
C	K 511	20.7	scar only		41.6	Left	2.5[2]	Anterior
D	K 511	18.1	10.2	♀	41.2	Right	1.8	Anterior
E	K 519	20.3	9.6	♀	38.6	Right	2.0	Anterior
F	31	13.8	5.9	♀	32.2	Right	1.9	Anterior
G	31	15.7	scar only		40.5	Right	1.5[3]	Anterior
H	31	7.9	3.6	⚥	44.0	Left	none[4]	Posterior
I	K 510	20.7	10.5	dead shell, detached from pecten				
J	K 554	20.9	11.2	dead shell, detached from pecten				
K	K 508	22.8	12.5	dead shell, detached from pecten				

All collecting stations were near Noumea, New Caledonia. All collections were made by the Natural Science Foundation - Academy Expedition, except at station 31.

Station 31: about 26 feet, weed, Anse Vata Bay. 4 April, 1959. A. & M. A. Lapelerie leg.

Stations K 508, K 510, & K 511: 9 to 15 feet, sand and turtle grass. Anse Vata Bay. December, 1960 and January, 1961.

Station K 519: 36 feet, sand, weeds, 5 miles ENE Dumbea Pass, off Noumea. 20 Dec., 1960.

Station K 554: 20 feet, sand, weeds, Baie de L'Orphelinat. 14 January, 1961.

[1] antero-posterior [2] healed [3] open [4] "clean" area under *Capulus*, no signs of drilling

Although either right or left valve may be pierced, the hole is anterior and dorsal, over or near the pecten's mouth. The location of these holes, which give access to the highest concentration of food within the pecten's mantle cavity, is too uniform to be the product of chance.

An examination of the preserved soft parts of Capulus danieli and Comptopallium vexillum gives further clues to the nature of this symbiosis. The gut of the capulids was filled with loosely-formed fecal pellets, containing pieces of algae, sand grains, and mucus—characteristic of many ciliary feeders, including Comptopallium vexillum. One would expect less solid matter in the feces of a true parasite feeding upon flesh and fluids. Excepting the drilled hole through the mantle, the soft parts of four of the drilled pectens examined were intact and unscarred. Therefore, on the basis of uniformity of drill hole position and gut content of the Capulus and the absence of damage to the pecten's soft parts, this appears to be a case of antagonistic symbiosis, not true parasitism. The Capulus steals food from the labial palps and food-gathering tracts of the pecten.

A presumption is made that the hole through the pecten valve is drilled. This seems reasonable in the light of Sharman's observations mentioned earlier and the beveled nature of the hole. Unfortunately, none of the specimens collected were in the process of drilling and the

Explanation of Plate 7

Capulus danieli (CROSSE) and *Comptopallium vexillum* (REEVE) from Noumea, New Caledonia.

Figure 1: Specimen "B" in situ on left valve of pecten. Figure 2: Side view of specimen "B" (x 3). Figure 3: Capulid scar and drill hole on left valve of pecten "B". Figure 4: Specimen "D" in situ on right valve of pecten. Figure 5: Side view of veliger from brood sac of *Capulus danieli*, specimen "A" (x 170). Figure 6: Part of radula, *Capulus danieli*, specimen "D" (x 160)

Figure 1

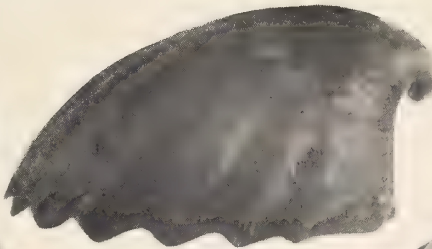

Figure 2

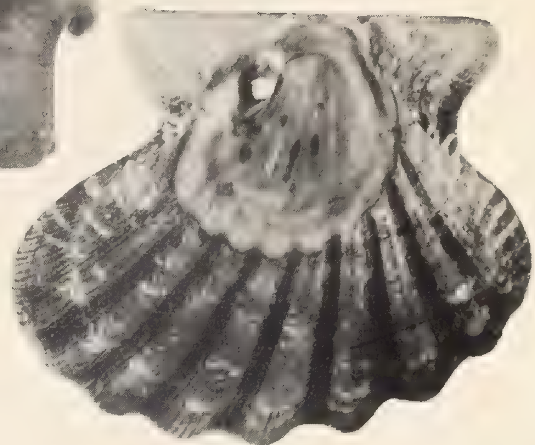

Figure 3

Figure 4

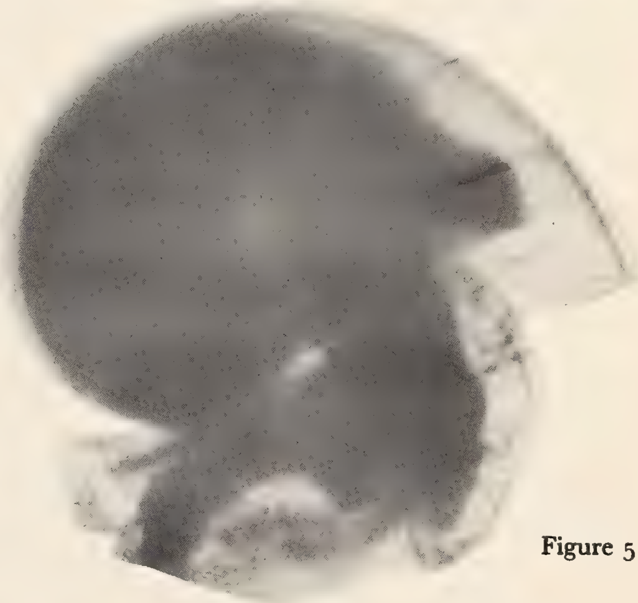

Figure 5

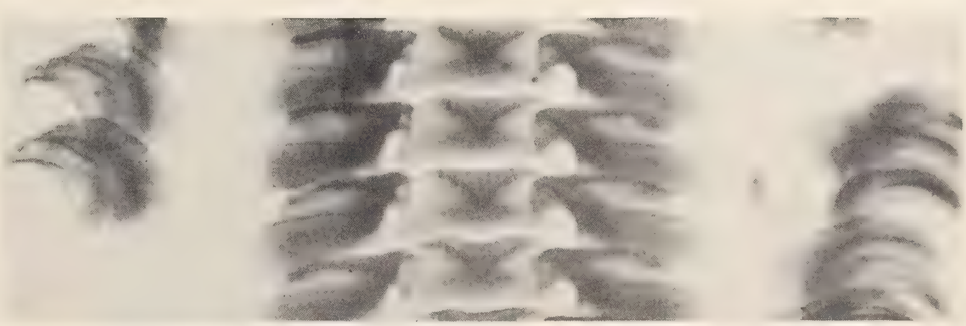

Figure 6

ORR, *photo*

radulae of five specimens examined showed only slight wear of the first three rows of teeth. The radula of an actively drilling specimen would probably show extensive wear.

The radula of specimen "D" is shown in Plate 7 and textfigure 5. This and the radulae of two other adult females had about 28 rows of hardened and about 8 rows of nascent teeth. That of the hermaphrodite specimen "H" had 20 hardened rows and 8 rows of nascent teeth. In specimen "H" the plates of the median and lateral teeth were slightly narrower but otherwise resembled those of the females.

Specimen "H" is particularly interesting because it is the only adherent Capulus danieli in our material which had not drilled. It is the only specimen attached to the posterior half of the scallop's shell, where it could not have benefited from the inhalant currents. Specimen "H" is, therefore, the only one of our New Caledonian capulids which was an independent ciliary feeder. It is also the only one which did not have the anterior third of its shell clogged by a brood sac of developing eggs or veligers.

Figure 2: Dorsal view of head of *Capulus danieli* (Crosse), specimen H, showing atrophied verge v. (x 8.0)

Yonge (1938) has shown that in the closely-related species Capulus ungaricus, food brought in by the inhalant current gathers in mucus-laden masses on the upper surface of the propodium, where it is picked up by the long, grooved proboscis and ingested. The efficiency of the current and food-gathering area must be impaired by the brood sac, which in C. danieli is also attached to the upper surface of the propodium.

In textfigure 4, the brood sac (bs) has been pushed down and to the left to show the capulid's head and proboscis (p). In all five preserved females examined, the head and most of the proboscis were buried in a hollow of the sac. The tip of the proboscis was folded posteriorly along the snail's right margin. This differs sharply from the position of the hermaphrodite capulid "H" shown in textfigures 2 and 3. The

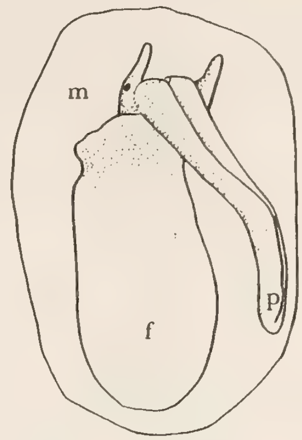

Figure 3: Ventral view of *Capulus danieli* (Crosse), specimen H; p - grooved proboscis, f - foot, m - mantle. (x 4.0)

position of the female's proboscis bent posteriorly along the right side explains the peculiar position of the drill-hole, especially if the hole is drilled after egg-laying commences.

The duration of the egg-laying and brooding period is not known. Females with relatively undeveloped eggs and those with well-developed veligers (Plate 7, Fig. 5) were collected both April 4, 1959 and late December, 1960. The veligers of specimens "A" and "F" had well-developed eyes and a velum which appeared to be bilobed, with lateral indentations on each lobe not unlike the velum of Capulus ungaricus (Lebour, 1937). However, the method of our capulid veligers' preservation, within the brood sac and in 70% grain alcohol, precluded detailed study. It was not possible to determine whether Capulus danieli veligers are echinospira as are Capulus ungaricus.

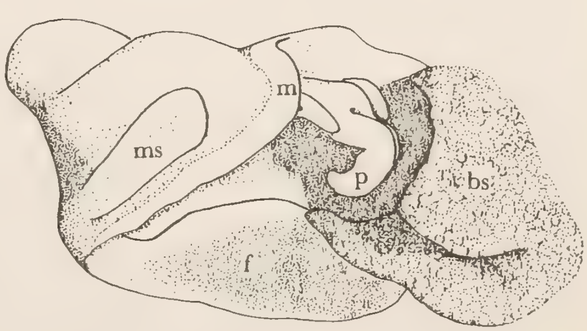

Figure 4: Side view of *Capulus danieli* (Crosse), specimen A; bs - brood sac, ms - mantle scar, other letters as in Figure 3. (x 1.2)

Figure 5: *Capulus danieli* (Crosse), specimen D
Half-row of radular teeth. (x 86.0)
Textfigures 1 to 5 from preserved material.

The effect of this food piracy upon the pecten is probably not seriously detrimental. Four of the largest undrilled and four drilled pectens collected the same time and place (Sta. K511) averaged 43.7 and 43.6 mm. in length (dorsoventrally) respectively. This is an insignificant difference. Although we did not collect any capulids attached to dead pectens, one live pecten had healed a hole presumably drilled by a Capulus. The characteristic shell scar was lightly incrusted, indicating that the capulid had dropped off its "host" pecten days or even weeks before it was collected.

A search of the literature revealed one account of shell-boring by a capulid. Garrard (1961, p. 12) described Capulus sycophanta, a new species from Keppel Bay, Queensland, Australia, which closely resembles and is possibly conspecific with C. danieli. Every adherent specimen of C. sycophanta examined by Garrard had bored a hole through the shell of its "host" scallop, Amusium balloti Bernardi. Garrard's illustrated specimen occupied a position similar to our specimen "F" but nearer the ventral margin. It was over the food-gathering tract along the tips of the Amusium's gills.

Schepman (1909, p. 119) reported a specimen of "Amalthea" danieli affixed to the gastropod "Gyrineum" cuspidatum Rve. It was "... easily loosened leaving a scar." but evidently had not drilled. There was no mention of a brood sac. A. W. B. Powell, of the Auckland Museum, said the New Zealand species, Capulus calcareus Suter, 1909, attaches to the columella and canal of the buccinid Penion dilatata (Quoy & Gaimard, 1833) but does not even etch out a shell scar, much less bore. It is frequently found on dead shells (written communication). Neither of these "hosts" are ciliary feeders. Although two Eastern Pacific capulids, Capulus californicus Dall, 1900 and Capulus sericeus Burch and Burch, 1961 are commensal on pectens (Pecten diegensis Dall and Pecten sericeus Hinds, respectively) neither species has drilled its host. One specimen of C. californicus in the Academy of Natural Sciences of Philadelphia collection and the figured specimen of C. sericeus are attached to the anterior-dorsal part of the pecten's valves where they probably benefit by the pectens' inhalant currents.

The development of a drilling habit in the New Caledonian and Australian capulids, Capulus danieli and C. sycophanta, presents an interesting problem. The advantage of a preconcentrated food supply during the critical brooding period is obvious. It is surprising, therefore, that the habit has not developed in more species. Possibly the duration of the brooding period in these species is comparatively longer than in non-drilling species. How the Capulus locates its drilling site without test-drilling is particularly puzzling. Unfortunately, excepting C. ungaricus, the capulids are little-known as living animals. The genus is largely represented in museums by dead-collected, detached shells and overlooked among the abundant, superficially similar Hipponix and Sabia in the field.

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Marine Pelecypoda from the North Alaskan Coast

BY

KUNIGUNDE HÜLSEMANN

Department of Biology, University of Southern California, Los Angeles 7, California

(1 Textfigure)

Introduction

The collection this study is based upon was obtained during a cruise of the LCM RED of the U. S. Coast and Geodetic Survey which in August 1953 travelled along the polar shore of Alaska from Barter Island (near the Alaskan-Canadian border) to Barrow, Alaska. During this cruise a scientific party including N. J. Wilimovsky, H. A. Fehlman, and Charles Horvath was able to occupy a number of hydrographic and collecting stations.

Previous Work

Our first knowledge of marine mollusks from the eastern arctic Alaskan area comes from material collected by the Canadian Arctic Expedition 1913-1918 at several stations along the northern Alaskan coast; a list of the mollusks has been published by Dall (1919). The material under consideration is only the second from that area to reach the hands of scientists. Besides this fact it is believed that the specific value of the collections and their data is that they were gathered in shallow, nearshore waters which are unlikely to be visited by any large-scale oceanographic expedition (see Wilimovsky, 1953).

The Area of Investigation

The area investigated extends in length roughly 500 km. The general character of the sea floor as indicated by the samples is composed of sediments of various grain size without extensive regions of rocks or boulders (see also Mohr, Wilimovsky, & Dawson, 1957; Carsola, 1952.)

The temperatures of the bottom water were negative (-0.8 to -1.35°C) at the (eastern) stations 2 to 11, positive (2.0 to 3.2°C) at the (western) stations 12 to 18, which group was taken in relatively shallower water. Possibly the positive temperatures indicate the presence of Bering Sea water. The decrease of the salinity reflects also the decrease of the water depth. In the adjacent Beaufort Sea, the currents are in a clockwise eddy. Close to shore, there exists a counter eddy which is indicated by the pattern of deposits at ends of islands.

The Stations

All dredging stations are located relatively close to shore in shallow water (Fig. 1). The depths extend from 3.65 m. down to almost 23 m. (station 5).

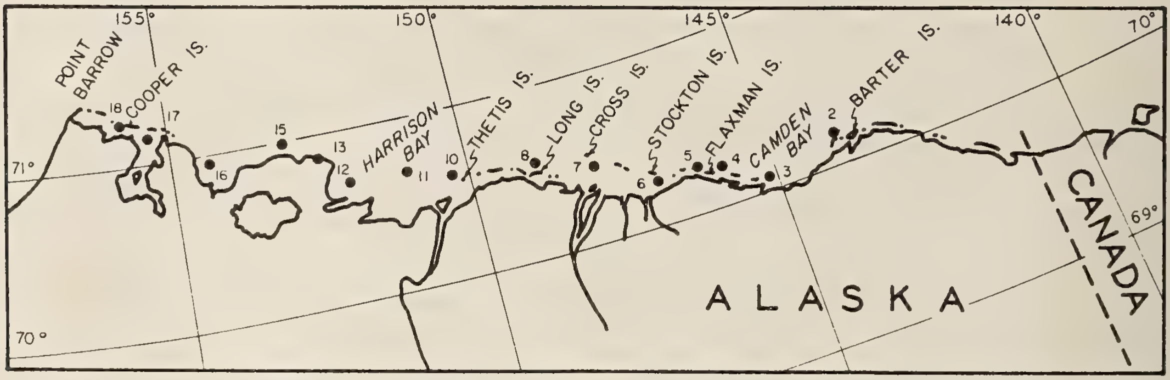

Figure 1: Dredging Stations of the LCM RED along the Arctic Coast of Alaska

The Pelecypoda reported here are part of the samples which were taken with a small biological dredge. The 15 stations are listed in Table 1 (from Wilimovsky, 1953). Stations 1, 9, and 14 are shore stations, at which no mollusks have been collected, and are therefore omitted. The following details are added to the original data listed in Table 1: Gravel was present in the samples of the stations 3, 4, 5, 6, 11, 12, 15, 17, 18. Clay was found also in station 3.

The Species Collected

In these 15 stations at least 12 species of pelecypods were collected. They have all been reported previously as inhabitants of arctic waters. The findings contribute to our knowledge of the species and their occurrence eastward beyond Point Barrow.

Table 2 is a list of the species collected. Also listed is their general distribution combined mainly from MacGinitie (1959), Soot-Ryen (1932), Hägg (1904), and Stuxberg (1882, 1887).

Shells of the arctic species are subject to marked variation. Pelecypods particularly mentioned by MacGinitie as highly variable are Musculus, Astarte, and Liocyma; species of these genera are found in the present collection. Among the variables are color of the shell, texture of the periostracum, the dimensions of the shell and their proportions.

Table 1. The Dredging Stations of the LCM RED Cruise Where Pelecypods Were Obtained

Station	Locality	Longitude West	Latitude North	Date Aug. 1953	Depth m [1]	Sediment type	Temperature °C [2]	Salinity % [2]
2	North of Arey Island	143°54′	70°08′	9	10.70	sand	-1.18	30.52
3	Off Kangigivik Point	145°14′	70°03′	9	7.30	sand	-0.8	30.01
4	Off Brownlow Point	145°55′	70°12′	10	12.80	? sand	-1.3	30.61
5	West of Flaxman Island	146°15′	70°11′	10	22.80	sand and mud		
6	South East Stockton Islands	146°50′	70°15′	10	4.60	sand and mud	-0.9	27.88
7	South of Cross Island	147°55′	70°26′	10	7.30-8.25	gravel	-1.0	30.25
8	North of Long Island	148°50′	70°31′	10	12.80	muddy clay	-1.35	29.76
10	Off Thetis Island	150°15′	70°34′	11	7.30	sand; clay	-0.8	30.30
11	East Harrison Bay	150°59′	70°43′	11	8.25	clay; sand	-1.0	29.94
12	Off Atigaru Point	151°50′	70°40′	11	4.60	sand	3.2	25.66
13	15 miles East of Pitt Point	152°25′	70°53′	11	6.40	clay	2.0	28.82
15	North West of Pitt Point	153°15′	70°57′	12	7.30	mud	3.2	26.78
16	Smith Bay	154°16′	70°57′	12	6.10	sandy clay	2.5	27.52
17	Sanigaruak Pass, Elson Lagoon	155°24′	71°11′	12	3.65-6.40	clay	2.8	21.96
18	Elson Lagoon, S. W. of Cooper Isld.	155°48′	71°13′	12	3.65	sand; clay	2.5	24.33

[1] originally in feet [2] data only for the bottom water

The color is a very unreliable specific characteristic. It varies individually; one predominant tone in all individuals throughout one sample indicates that it also depends on the immediate surrounding substrate.

The collecting data confirm the live occurrence of all the species collected in shallow water.

Shells drilled by Natica or Polinices (from MacGinitie, 1959) were rather frequent. Numerous holes of this sort were found in Cyrtodaria kurriana and Yoldia arctica.

Geographical Distribution

As mentioned above all species were reported earlier as members of the arctic fauna. With the exception of Yoldia myalis, their distribution is circumpolar; further, most of them occur also in subarctic or boreal areas.

The findings of Yoldia myalis, the distribution of which is considered to be discontinuous between the eastern and the western north American coasts (Ockelmann, 1954), narrow the gap between Point Barrow and the Hudson Strait. Pandora glacialis has not been recorded previously from the western part of the arctic seas of North America (Soot-Ryen, 1932). Dall (1919) listed Pandora sp. (fragments) from off Collinson Point. The finding of three intact specimens of P. glacialis in the RED collection indicates that the range of the species also includes the north Alaskan coast.

It is interesting to note that there are distinct differences from some of MacGinitie's findings (1959) on the marine mollusks from the area west of Point Barrow. Striking is the different number in which some species occur in the RED collection compared with that of MacGinitie. The most abundant species in the RED collection is Yoldia arctica of which 424 intact specimens were counted plus an additional large number of valves; MacGinitie found only one specimen. Cyrtodaria kurriana is quite frequent in the RED material although the majority of the specimens are empty. It is in striking contrast that the species was not found in the extensive collection of G. E. MacGinitie from west of Point Barrow. Still, C. kurriana was recorded in the Chukchi Sea (after Ushakov,

Table 2. The Pelecypods of the LCM RED Collection and Their General Distribution

	East Siberian Sea	Chukchi Sea	West Pacific	Bering Strait	East Pacific	West of Barrow	Point Barrow	East of Barrow	Canadian North Coast	West Atlantic	Greenland	Iceland	Spitsbergen	Barents Sea	East Atlantic	Murman Coast	Novaja Semlja	Kara Sea
Nucula tenuis	+	+	+[1]	+	+[9]	+	+	+	+	+[12]	+	+	+	+	+[16]	+	+	+
Yoldia arctica	+	+		+		+	+	+	+	+[10]	+	+	+	+	+[13]	+	+	+
Yoldia myalis		+		+	+[6]	+	+	+		+[10]								
Musculus niger	+	+	?	+	+[7]	+	+	+	+	+[12]	+		+		+[13]	+	+	+
Pandora glacialis	+	+		+	+[5]			+		+[10]	+		+	+		+	+	+
Lyonsia arenosa	+	+	+[1]	+	+[2]			+	+	+[10]	+		+			+	+	+
Astarte borealis	+	+	+[1]	+	+[3]	+	+	+	+	+[10]	+	+			+[14]		+	+
Astarte montagui	+	+		+	+[4]	+	+	+	+	+[10]	+	+	+		+[15]			
Liocyma fluctuosa	+	+	+[1]	+	+[2]	+	+	+	+	+[10]	+	+	+	+		+	+	+
Macoma calcarea	+	+	+[1]	+	+[8]	+	+	+	+	+[11]	+	+	+	+	+[14]	+	+	
Macoma moesta	+	+	+[1]	+	+[8]	+	+	+	+		+		+	+			+	+
Cyrtodaria kurriana	+	+		+				+			+						+	+

The superior numbers stand for localities which represent the southernmost finding of the particular species. Key to numbers: [1] Japan; [2] Kodiak Island; [3] Prince William Sound; [4] British Columbia; [5] Strait of Juan de Fuca; [6] Puget Sound; [7] Oregon; [8] Monterey Peninsula, California; [9] Coronados Islands, Mexico; [10] Massachusetts; [11] Long Island, New York; [12] Cape Hatteras, North Carolina; [13] Scotland; [14] Denmark; [15] Bay of Biscay; [16] Mediterranean Sea.

1952) and on the Chukchi Peninsula (Leche, 1883), and was mentioned in a few stations of the Canadian Arctic Expedition: at Port Clarence near Teller (Seward Peninsula), Alaska; at Spy Island off the north Alaskan coast; and other stations (Dall, 1919). Hiatella arctica, in turn, which was the most abundant and most nearly ubiquitous species in MacGinitie's collection, was lacking in the RED material. Another species, that was rather frequent in the collections west of Point Barrow, is Nucula tenuis; only two damaged valves were in the RED collection.

Acknowledgment

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Systematic Section

Nomenclature and taxonomy of the pelecypods are used as by MacGinitie (1959).

Nuculidae

Nucula tenuis (Montagu, 1808)

Only 2 left valves and some fragments were taken at stations 8 and 11. The valve in station 11 is 10.7 mm. in length; the height could not be measured exactly, since the umbo was broken away, but might have been about 8 mm.

These specimens belong to the var. expansa Reeve. The color of the periostracum is olive, the growth lines are brown and prominent. Nucula tenuis var. expansa seems not to be rare in other places. In MacGinitie's collection (1959) it was one of the species occurring in numbers. Dall (1919) did not list it from the area under investigation.

This is the first record of the species on the northern Alaskan coast. The distribution is circumarctic and circumboreal.

Nuculanidae

Yoldia arctica (Gray, 1824)

Yoldia arctica was the most abundant species in the collection; 424 intact specimens, 2 dead, 257 right, 205 left valves were counted. The species was present in every station, in greatest numbers in station 6 (179 living, 15 right, 13 left valves) and station 11 (96 living, 196 right, 151 left valves). In stations 7, 12, and 15 were only single valves.

The two largest living specimens (of 75 measured) are 14.8 mm. in length by 9.0 mm. in height by 5.6 mm. in breadth and 13.5 mm. by 8.1 mm. by 4.3 mm.; the two smallest living specimens were 3.7 mm. in length by 2.6 mm. in height by 1.7 mm. in breadth and 3.9 mm. by 2.5 mm. by 1.7 mm. The largest single shells were 17.3 mm. by 10.1 mm. and 14.5 mm. by 9.6 mm. The ratio height/length (H/L) of 74 specimens varied from 0.57 to 0.74, with a peak in the range of 0.63 to 0.68. The ratio breadth/length (B/L) varied in 54 specimens from 0.32 to 0.48. In 16 specimens there were 13 to 16 anterior (f) and 10 to 13 posterior (b) hinge teeth the ratio f/b of which being 1.14 to 1.33.

Most of the specimens belong to the typical form and the var. siliqua Reeve with transitional forms. Some come very close to Yoldia collinsoni (synon. Leda (Portlandia) collinsoni Dall, 1919), from off Collinson Point, arctic Alaskan coast. In these the ratios H/L and B/L correspond to the dimensions in the description of Dall, three specimens are even a little stouter, whereas the size of the shells is somewhat larger (10.0 mm. and more in length; Dall: 8.5 mm.). The ratio of the anterior to the posterior hinge teeth (f/b) of Yoldia collinsoni is, according to Dall's description, with 1.37 a little higher than in the RED specimens. Here are compared the proportions of the shells rather than the plain measurements, a method Ockelmann (1954) used when revising some other arctic species of the genus. Between the shells of both, Y. arctica and Y. collinsoni, is a continuous transition from elongate to stout forms. It is therefore proposed not to retain Y. collinsoni as a valid species.

The color of the periostracum is highly variable in the specimens in the collection. All gradations of color from greyish brown and yellowish tan to olive black are found. All of the shells show marked growth cessation lines. Usually the living specimens in one station are quite uniform in color, also often in size and shape. This observation is true especially for Yoldia arctica and Liocyma fluctuosa. This fact points to an immediate strong relationship of the animals to the local living conditions. The finding in great numbers is in contrast to the one specimen found by MacGinitie. Many single shells are drilled.

Yoldia myalis (Couthouy, 1838)

Forty-nine intact specimens, 16 right and 20 left valves were found in stations 10, 11, 12, 16, and 18, whereof 25 living specimens and 11 right and 12 left valves came from station 10 alone.

The largest specimen (of 25) measures 11.6 mm. in length by 7.1 mm. in height by 4.3 mm. in breadth. The smallest is 9.0 mm. by 5.7 mm. by 3.3 mm. The ratio H/L in 25 specimens is 0.54 to 0.68 with a distinct maximum in the range of 0.57 to 0.64; B/L in 20 specimens is 0.33 (0.30) to 0.39 (0.41). In 5 specimens the anterior hinge teeth are 12 to 15, and the posterior hinge teeth 10 to 12; the ratio f/b in 5 specimens is 1.1 to 1.3.

The proportion H/L Ockelmann (1954) gave for Yoldia myalis is 0.52 to 0.55, which means, that his specimens were more slender; however, the ratio from measurements of Couthouy (1838) is within the variation of the RED animals. The ratio f/b fits the numbers of Ockelmann. Apparently the specimens from the arctic Alaskan coast are considerably smaller than those found in other areas.

The color varies from nearly ocher yellow to dark olive brown. As in Yoldia arctica all living specimens in one station are almost uniformly colored and of similar size. Growth cessation lines are more distinct in the darker shells.

The recent occurrence of Yoldia myalis was recorded only from the east and west coast of North America and not yet known between Point Barrow and Hudson Strait, wherefore Ockelmann suggested it should be considered discontinuous. The findings in this collection extend the known range for some 250 kilometers eastward from Point Barrow.

Mytilidae

Musculus niger (Gray, 1824)

Only one intact juvenile specimen of 3 mm. length at station 6, one empty shell of 7.6 mm. length at station 3, and a few single shells (the longest one 10.5 mm.) and fragments were taken at stations 3, 6, and 16. At station 7 two tiny Musculus sp. of less than 1 mm. length have a light olive color.

The color of the empty shell is brownish olive becoming darker on the margin.

The species is circumarctic and circumboreal.

Pandoridae

Pandora glacialis Leach, 1819

Three intact specimens were taken at the stations 4, 8, 11, and five right and 4 left valves at station 3, 8, 11, 15. The largest living specimen is 17.2 mm. in length by 10.0 mm. in height; the posterior dorsal margin from the umbo to the posterior end 10.5 mm. The largest single shell (left) is 21.0 mm. in length by 13.2 mm. in height; the posterior dorsal margin 13.9 mm. Probably the specimens belong to the typical form.

The shells of Pandora glacialis have exceedingly thin margins. The younger valves are transparent. Some of the valves have been drilled.

This species was not found in the collection of MacGinitie (1959). Dall (1919) recorded Pandora sp. from off Collinson Point. The three intact specimens in this collection prove the presence of the species in the western part of the arctic coast of North America for the first time.

Lyonsiidae

Lyonsia arenosa (Möller, 1842)

One empty pair of valves was collected at station 16; 20 right and 20 left valves were present in stations 8, 10, 11, 12, 15, 16, 17. The largest valve (left) measures 21.0 mm. in length by 12.5 mm. in height.

This species was not in the collection of MacGinitie (1959), who found Lyonsia norvegica which, in turn, was not present in the RED material.

Dall (1919) listed Lyonsia arenosa at two stations on the north Alaskan coast. It is circumarctic and circumboreal.

Astartidae

Astarte borealis (Schumacher, 1817)

Occurring at all but two stations, 22 intact specimens, 18 empty valves, 13 right and 27 left valves plus additional fragments were dredged. The largest intact specimen is 26.5 mm. in length by 17.1 mm. in height by 7.3 mm. in breadth. The largest valves taken dead are 35.2 mm. by 28.8 mm. by 11.2 mm. and 34.9 mm. by 28.4 mm. by 9.1 mm. The largest single shell is 38.0 mm. by 29.2 mm.

The shell of Astarte borealis shows great variation in the proportion of the length to the height, and the general shape. Most specimens represent the strongly compressed and elongate form (Figs. 1d and 1e in Plate 4: Jensen, 1912; and Figs. 5 and 6, Plate 22: MacGinitie, 1959). The sculpture of the shell is rather smooth, or, more often, has distinct concentric folds around the umbones. Usually the transition from the folds to fine lines is abrupt. The thick periostracum varies from dark brown to black; often it becomes lighter brown and thinner near the umbones. The umbones are often eroded. Some shells have, as MacGinitie also mentions, a rustlike deposit or concretion on the shell, especially on the anterior end.

Also a number of smaller shells of less than 8 mm. length was found. They are distinctly thinner, and the periostracum is much lighter in color. Even some of these younger specimens have eroded umbones.

A number of the dead shells was closed tightly as if alive, and some of them were filled with mud as mentioned by MacGinitie (1959).

Astarte borealis is circumpolar and circumboreal.

Astarte montagui (Dillwyn, 1816)

Astarte montagui is the third most frequent species in the RED collection; 110 intact, 2 dead specimens, and 26 right and 24 left valves were found in eight stations. In stations 3 and 4 alone were 100 intact animals taken. The largest living specimen measures 19.0 mm. in length by 17.4 mm. in height by 6.0 mm. in breadth. Only very few large shells were present; most are about 10 mm. long.

Astarte montagui exhibits great variation in shape, sculpture, and color. Jensen (1912) separated the varieties of the species by the statistical method; between these exist all transitional forms. Most of the specimens in the collection can be assigned to the varieties striata, fabula, and warhami. Fine, evenly spaced concentric lines around the umbones vary in spacing and prominence. The color of the young shells is yellowish tan, lighter near the umbones, and of the larger living ones, chestnut brown. The larger dead ones lack the chestnut tint. Some have a black concretion near the dorsal margin.

MacGinitie found Astarte montagui to be one of the most abundant species west of Point Barrow.

Astarte montagui is here recorded for the first time from the arctic Alaskan coast east of Point Barrow.

It is a circumarctic and circumboreal species.

Tapetidae

Liocyma fluctuosa (Gould, 1841)

Liocyma fluctuosa was the second most frequent species in the RED collection; 206 intact, 11 dead specimens, 49 right and 36 left valves were counted. The species was present in all but one of the stations. The greatest number of living specimens (85) came from station 3.

The largest living shell is 16.0 mm. long by 12.2 mm. high; the smallest is 3.5 mm. long. The largest single shells are (2 left valves) 27.5 mm. in length by 18.6 mm. in height and 21.7 mm. by 16.0 mm; and (1 right valve) 25.5 mm. by 17.8 mm. These three large single shells have a relatively thick periostracum of yellow or brownish, respectively. They are shaped exactly like the Liocyma viridis Dall.

MacGinitie (1959) considers five other species (Liocyma beckii, L. scammoni, L. viridis, L. aniwana, L. schefferi) as variants of L. fluctuosa. The many specimens of L. fluctuosa in the RED collection confirm her finding that the young specimens tend to be more trigonal than larger specimens. Here are by far more small than large specimens.

The smallest shell is transparent (3.5 mm. in length). The color of the other living shells is ivory white with grey, yellow or greenish tint. The concentric sculpture is more or less evenly spaced. In old as in young specimens the umbones are usually worn.

Liocyma fluctuosa occurs in all arctic seas and is also circumboreal.

Tellinidae

Macoma calcarea (Gmelin, 1791)

[in a number of other papers quoted as (Chemnitz, 1782); Neues System. Conchyl. Cabinet 6]

Only one right and one left valve were found at stations 5 and 11. The one large (left) shell is 36.0 mm. in length by 23.6 mm. in height. Some fragments of a Macoma sp. were also at stations 6, 8, 10, 12.

MacGinitie (1959) mentioned Macoma calcarea as one of the three most abundant species in the collection west of Point Barrow occurring in extremely sticky mud. The bottom at the stations 5 and 11 contained also mud and clay.

Macoma calcarea is found throughout the arctic; it is also circumboreal.

Macoma moesta (Deshayes, 1854)

Three intact specimens, 2 right and 4 left valves were found in station 2, 3, 11, 12, 16.

The largest living specimen is 19.2 mm. long by 13.6 mm. high. Usually the brittle shell of Macoma moesta is damaged and does not permit an exact measuring. The relatively thin periostracum extends onto the interior surface.

Along the posterior end and the ventral margin there is a brownish concretion as mentioned by MacGinitie (1959).

Macoma moesta occurs throughout the arctic seas; it is also circumboreal.

Myacidae

Mya spec.

The beak areas of three Mya sp. were found in stations 4, 7, and 12. They have been worn considerably.

Saxicavidae

Cyrtodaria kurriana Dunker, 1862

Rather frequent species in the RED collection; 16 intact, 75 dead specimens, 32 right and 28 left valves were taken in stations 5, 6, 7, 10, 11, 12, 17, 18. The longest living shell is 22.0 mm., the longest dead shell is 29.3 mm., the longest single valve is 31.7 mm. in length. Many of the dead shells are drilled.

Cyrtodaria kurriana was not found in MacGinitie's (1959) collection. This surprises since most of the shells in the RED collection came from stations 17 and 18 which are the closest to Point Barrow. The distribution is circumpolar although C. kurriana is not yet found in all arctic waters and not at every locality alive.

MacGinitie found Hiatella arctica (Linnaeus) (also fam. Saxicavidae) to be the most abundant bivalve; not a single specimen was present in the RED collection.

Summary

The collection on hand was dredged during a cruise of the U. S. Coast and Geodetic Survey LCM RED along the north Alaskan coast between Barter Island and Point Barrow. Twelve species of pelecypods were taken which have been known from arctic seas. For four of them this is the first record in the area of investigation.

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Cypraea chinensis Gmelin, 1791 (Gastropoda) in Hawaii

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(Plates 8, 9)

After a careful study of specimens of Cypraea chinensis Gmelin, 1791 (synonyms: C. variolaria Lamarck, 1810; C. cruenta Dillwyn, 1817), in various collections throughout the United States and of pertinent literature, with particular attention to the visible morphological variations in its several allopatric subspecies, I am convinced that a separable population of this species exists in the Hawaiian Islands, because of the outstanding differences noted in this Polynesian race.

Melvill & Standen (1915) were the first to recognize the divergence of the Hawaiian race from the typical species and they singled out their semipellucid specimen, giving it the name Cypraea variolaria amiges. Since they based their subspecies upon a single dead specimen from a doubtful locality, this name has subsequently disappeared into synonymy through a lack of recognition of its existence. Cypraea chinensis is of rare enough occurrence in Hawaii that until recently not enough live-taken specimens have been known to make such an identification possible. However, during the past few years several specimens have been collected in Hawaii, and it seems appropriate, with the additional information now available, to validate the early subspecies, to illustrate it (probably for the first time), and to discuss the distinguishing morphological characters and ecological environment that so clearly separate it from the other races of the species.

Although they did not know the exact locality of their new subspecies, Melvill & Standen made an excellent inference that it was probably from the Hawaiian Archipelago. They based their conclusion upon the fact that the new form stood in the same relationship to typical Cypraea chinensis as did certain other Hawaiian forms to their respective typical species; to cite only one of their examples, such as C. helvola hawaiiensis does to C. helvola helvola. Their explanation referred mostly to a similarity in pellucidity and coloration, but a careful reading of their description of the subspecies makes it certain that the form they were describing is indeed the form found today in Hawaii.

The authors of the new subspecies acknowledged the help of Mr. J. Kidson Taylor in calling to their attention that the shell they named Cypraea variolaria var. amiges was allied to C. chinensis. About a year later, Taylor (1916) noted enough differences in Japanese specimens to describe them as still another subspecies of C. chinensis, namely, C. variolaria (= C. chinensis) var. splendens. The description of Taylor's holotype could apply equally to that of C. c. amiges and tends to ally it with the Hawaiian race. I have seen Japanese specimens of both the amiges form and the chinensis s. s. form, leading me to the conclusion that Japan may be the area where the two subspecies overlap. Therefore, since the name amiges for this race has nearly a full year's priority and since the typical amiges form seems restricted to Hawaii, Taylor's C. c. splendens must go into the synonymy of C. c. amiges.

Cypraea chinensis amiges (see Plate 9, Figs. 1a, 1b, 2a, and 2b, Table 1) is a noticeably shorter, broader shell than C. c. chinensis (see Plate 9, Figs. 3a, 3b, 4a, and 4b, Table 2), with its width almost invariably 70 percent as great as its length; Melvill & Standen used the term "broadened" to point out this important feature. The shell, however, is more than "normally

shaped", as they expressed it. Its unusual breadth and produced marginal callus, reaching near to the highest point on the dorsum, give the shell a somewhat flat, squat appearance, whereas *C. c. chinensis* is a more cylindrically oblong shell, usually much less heavily callused along its margins and of a lighter porcellaneous texture. The marginal callus, covering a large area of the dorsal surface, is very thickly marked with large spots of a deep violet color; it covers at least half of the swollen base in the columellar area, and all of the base formed by the horizontally flattened lip. In the typical species a broadening of the right and left portions of the base is more noticeable. The white teeth, bold and strong on the lip (16 in number), short and very fine on the columella (18 in number) have brilliant orange-red interstices, while those of *C. c. chinensis*, bordering on a longer and straighter aperture, seem larger and less crowded. Also, Philippine specimens appear to have more teeth. The columellar teeth of *C. c. amiges* extend as strong concave ridges across the very broad, prominent white fossula. Irregularly rounded lacunae, of the same creamy color as the background of the shell, show through the straw-colored layer of the narrowed dorsum. Not having the dorsal surface area so narrowed by the marginal callus, the straw-colored pattern of the typical *C. chinensis* covers a larger area; it is also more irregular and scattered. These features, plus the narrow, sharply recurved aperture constitute the greatest morphological changes evident in this Hawaiian subspecies. A character common to all the races of *C. chinensis* is the faint mantle line traversing the right dorsum near its summit. It is interesting to note, however, that in the case of the East African *C. c. violacea* there are some instances where the mantle line is exceedingly faint or does not appear to exist at all. This would seem to be more of an exception than a rule for this subspecies.

As a result of the careful observations of Clifton S. Weaver, I am able to include here a detailed description of the animal of *Cypraea chinensis amiges*, from one of the specimens he collected in Kailua Bay.

The mantle of the animal is blood-red, with darker, almost brownish spots spreading out over the sides, and white, frosty-appearing spots along the margins. The papillae are bumpy, stalk-like, and about 4 mm. in length. Numbering approximately 35 on either side, they are off-white in color, shading to a pale salmon. The eyestalks are a pale golden-yellow, with the siphon a paler orange-yellow, becoming white at its tip. The ventral surface of the foot is more or less white, ornamented with red-brown lines; the base of the foot is off-white, evenly tinted with red-brown.

Cypraea chinensis amiges prefers living in a deep-water habitat, its present known benthic range in Hawaii being from 30 to 60 feet. The specimens taken in the shallower depths were collected at Waikiki and Makua, on the south

Table 1

Measurements (in millimeters) and Collecting Data of Specimens of *Cypraea chinensis amiges* MELVILL & STANDEN, 1915, Used in this Study.

	Length	Width	Height	Dentition Lip	Columella	Locality	Collecting Depth, feet	Collector	Notes
Hypotype 1	29.1	19.5	15.5	18	17	Makua, Oahu	35	T. Richert	
Hypotype 2	32.7	23.9	16.8	15	17	Mokolea Rock, Kailua Bay, Oahu	55	C. S. Weaver	1
Hypotype 3	33.0	23.7	17.0	15	18	Mokolea Rock, Kailua Bay, Oahu	50	C. S. Weaver	2
Hypotype 4	33.2	24.7	17.1	16	19	Makua, Oahu	60	C. S. Weaver	3
Hypotype 5	37.0	25.5	18.7	17	17	Waikiki, Oahu	35	J. Lucas	4
Hypotype 6	37.7	26.8	19.8	16	18	Makua, Oahu	35	R. Lee	5
Hypotype 7	38.9	26.4	20.0	18	17	Makua, Oahu	35	T. Richert	6

[1] under basalt boulder, 20 Jan. 1962. [2] under lava rock, 13 Jan. 1962. [3] edge of underwater lava island, June 1957 [4] under coral slab [5] under lava rock [6] April 1958

Table 2

Measurements (in millimeters) and Dentition of Specimens
of *Cypraea chinensis chinensis* Gmelin, 1791, Obtained from Moro Collectors and Used in this Study.

	Length	Width	Height	Dentition Lip	Columella	Date	Locality
Hypotype 1	23.3	12.7	10.1	18	17	1962	Siasi Island, Sulu Archipelago
Hypotype 2	26.6	14.3	10.2	18	17		
Hypotype 3	27.7	14.9	11.9	17	16		
Hypotype 4	30.6	16.6	13.4	18	18		
Hypotype 5	30.7	17.0	13.6	19	18		
Hypotype 6	30.9	17.4	13.8	18	18		
Hypotype 7	31.2	17.9	13.6	19	20		
Hypotype 8	34.7	18.8	15.0	20	19		
Hypotype 9	36.0	19.8	15.7	20	18		
Hypotype 10	37.1	21.0	16.3	19	19		
Hypotype 11	42.1	23.5	18.5	21	18		

Hypotypes 10 and 11 are illustrated on Plate 9

shore of Oahu, while two specimens were collected on the northeast shore of the island (within 100 yards of one another, and a day apart) in 55 to 60 feet of water (Kailua Bay). The Waikiki specimen was taken from under a coral ledge. It is not known how the Makua specimens were taken, but this collecting area is noted for its dead coral heads and lava outcroppings, with portions of the bottom clear and barren except for an occasional sparse growth of eelgrass. (Underwater photographs taken by Roland Gray confirm this condition.) The substrate adjacent to the Mokulua Islands where the Kailua Bay specimens were taken consists of basalt and coral ledges and slabs.

The ecology of some of the other races of Cypraea chinensis is quite different. For the most part they are reef-dwellers or are at least shallow water species and are far less rare than in Hawaii. In Mozambique and Zanzibar, for example, C. c. violacea is collected in such quantities that dealers have it in their shops by the boxful. At Siasi Island in the Sulu Archipelago, C. c. chinensis is taken in reasonably plentiful numbers by native collectors in shallow water. In Hawaii, on the other hand, C. c. amiges is known from a total of only about 16 specimens, of which seven have been loaned to me for this study through the kindness of several Hawaiian collectors. The Hawaiian race (as C. cruenta Gmelin) is reported by Ostergaard (1928) in the Hawaiian Pleistocene as rare.

Schilder (1938) lists the living range of Cypraea chinensis chinensis Gmelin, 1791, as "N. E. Malaysia to Japan, Hawaii, Palmyra Island, New Caledonia, N. W. Australia and S. W. Java." It is my belief that Hawaii should be excluded from the range of the typical species, as the subspecies discussed in this paper can be differentiated and is an apparently isolated race, ecologically as well as morphologically. Further research will be required to determine to what extent its range goes beyond the immediate vicinity of Oahu. I note with interest that some of the typical morphological characters of C. c. amiges are sometimes (but not always) seen in

Explanation of Plate 8

Cypraea chinensis amiges Melvill & Standen, 1915

Ventral and dorsal aspects of typical specimens.

Figures 1a and 1b: Hypotype 3. Figures 2a and 2b: Hypotype 2. Figures 3a and 3b: Hypotype 4.
(All figures x 1.5)

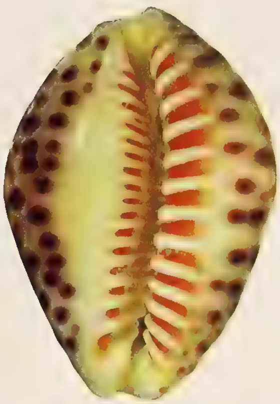

Figure 1 a

Figure 2 a

Figure 3 a

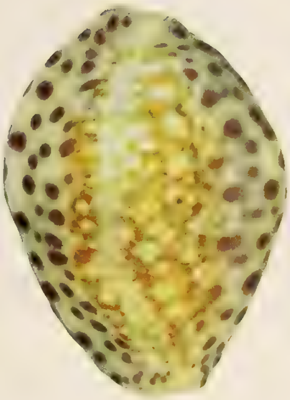

Figure 1 b

Figure 2 b

Figure 3 b

Kodachromes by A. BLAKER


Figure 1 a

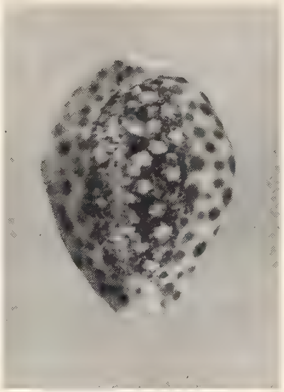
Figure 1 b


Figure 2 a

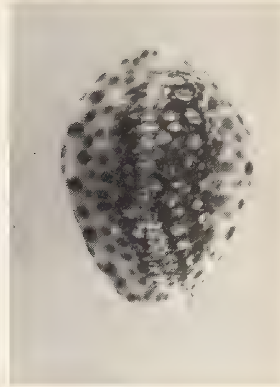
Figure 2 b

Ventral and dorsal aspects of typical *Cypraea chinensis amiges* MELVILL & STANDEN, 1915
Figures 1a, 1b: Hypotype 2 Figures 2a, 2b: Hypotype 3
These specimens collected at Mokolea Rock, Kailua Bay, Oahu; *ex* Weaver collection


Figure 3 a


Figure 3 b


Figure 4 a


Figure 4 b

Ventral and dorsal aspects of typical *Cypraea chinensis chinensis* GMELIN, 1791
Figures 3a, 3b: Hypotype 11 Figures 4a, 4b: Hypotype 10
These specimens collected at Siasi, Sulu Archipelago; *ex* Cate collection

TAKEO SUSUKI, *photo.*

specimens allegedly from Japan; it is therefore possible that the range may extend almost as far west as the Japanese Islands.

The type locality of Cypraea chinensis amiges Melvill & Standen, 1915, is here designated as Kailua Bay, Oahu, in the general area of Mokolea Rock (19° 38' N. Lat., 155° 59' W. Long.).

Both Cypraea amiges and C. splendens have been placed in the synonymy of C. chinensis chinensis by Schilder (1932), but I feel there are enough physical and ecological differences to be found in the Hawaiian specimens (and in some Japanese specimens) to separate them as an independent geographical race, surviving and maintaining themselves as such.

It is the intention of this paper to restore a forgotten subspecies to its rightful place in the Hawaiian fauna. Due to its rarity in past years, one can readily understand why little has been said about it; however, the recent discoveries of this form by Hawaiian collectors have brought a heretofore obscure race out into the open. The diagnostic characters are clear.

It should be mentioned that the color transparency furnished for the accompanying color plate was slightly overexposed, resulting in some loss of red tones. However, due to the careful work of Dr. and Mrs. G Dallas Hanna of the California Academy of Sciences (to whom I am indebted for the time spent in making this attractive plate) the fidelity of color tones and the sharpness of detail in the final work are remarkable; the plate is an exact reproduction of the original transparency, even to showing a few air bubbles which the photographer was unable to discern while taking the photograph under water to minimize reflections. A freshly collected specimen of Cypraea chinensis amiges has a pinkish base rather than the beige-colored one shown here.

Acknowledgment

I wish to express my deep gratitude for the aid and fieldwork of my friend and co-worker Clifton S. Weaver of Honolulu, and my thanks to others, including Dr. T. Richert, Robert Lee, and James Lucas for the loan of their specimens used in this study. To my wife Jean Cate, as always, for the help given in many ways, I give my deepest appreciation.

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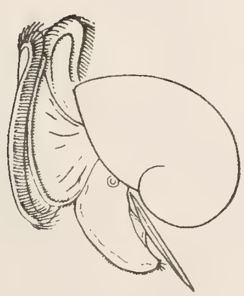

Aspects of Ctenidial Feeding in Immature Bivalves

BY

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(2 Textfigures)

Introduction

The margins of the two gills, or ctenidia, of most adult bivalved mollusks are grooved. The grooves are ciliated and function in the transfer to the mouth of potential food particles that the ctenidia filtered from the so-called respiratory water current. The suggestion has been made and accepted in the literature that the ctenidia of developing bivalves cannot function in this way until the marginal food grooves make their appearance (Yonge, 1947; Allen, 1961). The acceptance of this suggestion as a "fact" is premature, for the limited observations related below have proved it to be untrue.

Observations

The adult ctenidia of Modiolaria laevigata Gray are similar in cross-section to those of Mytilus; that is, each is "W"-shaped with a food groove along the margin of each "V", or demibranch (see Atkins, 1937, p. 383). Of one specimen of Modiolaria only 1.9 mm. greatest dimension, 21 ctenidial filaments had formed on either side of the body. Of those on the right side, the 13 nearest the mouth consisted solely of descending and ascending filaments of the inner demibranch. The remaining 8 filaments bore rudiments of the descending arm of the outer demibranch (Fig. 1). Despite the facts that there was neither a food groove on the inner demibranch nor a "complete" outer demibranch, ciliary currents along all free margins, including that of the unreflexed outer demibranch, carried particles towards the mouth. In the young as in the adult there is also a strong ciliary tract in the axis of the ctenidium between the demibranchs. If in Modiolaria the development of these earlier filaments is like that of Mytilus, the short papillae comprising the descending arm of the outer demibranch will continue to grow downwards and then bend back upon themselves leading to the completed "W"-shape of the adult ctenidium.

Cross-sections of the right ctenidium of Venericardia ventricosa Gould (Carditidae) at three stages of development are shown in Figure 2. The inner demibranch develops before the outer, with orally directed tracts of cilia being present along its margin even in the absence of a food groove (Fig. 2A). The ctenidium passes through a stage, when the animal is about 3.1 mm. greatest dimension, in which the outer demibranch is represented by small reflexed filaments that seem to lack orally directed tracts along their margins (Fig. 2B); ciliary tracts lead particles over the margin of the outer demibranch into the axis of the ctenidium where a strong tract persisting from younger stages leads them towards the mouth. A shallow food groove is present on the inner demibranch (MGI). The only available specimen in this size range died before the existence of orally directed

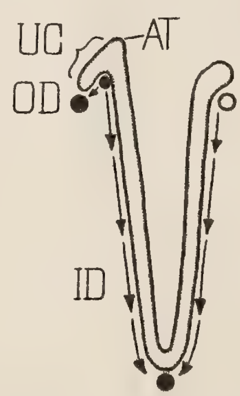

Figure 1: Diagrammatic cross-section of the ctenidium of *Modiolaria* at an early stage of development.
AT: area of attachment of ctenidium to body
ID: inner demibranch
OD: outer demibranch
UC: unciliated abfrontal surface of outer demibranch
• : strong orally directed currents
o : weaker orally directed currents
Arrows indicate direction of beat of frontal cilia

tracts along the edges of the reflexed segments could be ascertained, but such are probably present.

At 4.9 mm. greatest dimension this species has well-developed food grooves on the inner demibranchs and weak, orally directed tracts on the ungrooved margins of the outer demibranchs (Fig. 2C). Approximately the upper half of the ascending filaments bears frontal ciliation beating towards the reflexed edge. The proportion of the length of the reflexed portions of the outer filaments given to this type of frontal ciliation becomes somewhat larger as the organism grows, but the general arrangement is similar to that of adults of 18 mm. greatest dimension.

Although Venericardia is eulamellibranchiate when adult, interfilamentary junctions of the ctenidium seem to be entirely ciliary at very early stages.

Conclusions

The inner demibranchs of Modiolaria and Venericardia are functional, food-collecting organs before the outer demibranchs commence their development. It is probably characteristic of all bivalves that elements of the inner demibranchs appear before those of the outer (Rice, 1908; Creek, 1960). While the amount of water passing over their surfaces is no doubt small, the outer demibranchs from their first appearance seem to be food-collecting structures. The ctenidial axis will probably be found to be significant in leading particles to the mouth.

At a stage intermediate in development (Fig. 2B), a cross-section of the ctenidium of Venericardia bears some resemblance to that of adult Cardiidae (see Johnstone, 1900), although that family lacks the orally directed tracts along the reflexed margins of the ctenidia.

The arrangement of the frontal ciliation of Venericardia ventricosa is unique among known bivalves. The division of frontal ciliation on the ascending lamellae of the outer demibranchs recalls that of the Unionidae (Atkins, 1937, p. 408), but that family lacks orally directed tracts on the margins of the outer demibranchs and of the reflexed margins of the inner ones.

While there are structural and functional differences between the organs and methods of feeding of young and adult bivalves (see Allen, 1961), the general rôle of food collection probably may be attributed to the ctenidia shortly after their first appearance. Their function cannot be deduced from form alone.

Acknowledgment

The above observations were made while the author was at the Friday Harbor Laboratories of the University of Washington where financial support was received from the Office of Naval Research.

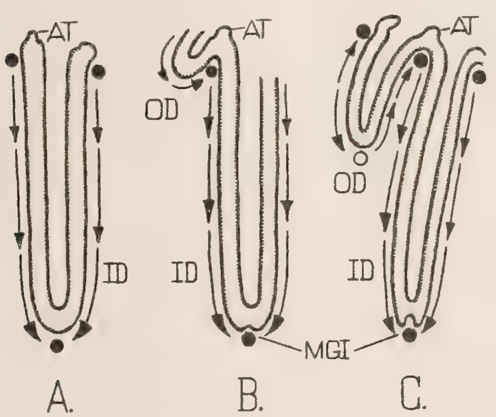

Figure 2: Diagrammatic cross-sections of the ctenidium of *Venericardia* at three stages of development.
MGI: marginal food groove
Other abbreviations as in Figure 1

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A New Species of *Mitra* (Gastropoda) from Hawaii

BY

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(Plates 10, 11)

In January 1962 I published in this journal (The Veliger, Vol. 4, No. 3, pp. 140-149) a paper concerning 13 species of Mitra from Hawaii that had been described by Pilsbry in 1920. At that time Mitra langfordi Pilsbry was placed in the synonymy of M. peasei Dohrn, 1860, that species having proved to be identical with Pilsbry's holotype. During the ensuing months I have received inquiries from several collectors in Hawaii, saying in effect "What has become of the species we used to call Mitra langfordi?" It developed that they had erroneously applied the name M. langfordi to a species actually quite different from M. peasei, though with certain superficial morphological similarities. Pilsbry's inadequate illustration was an unreliable guide, and his description could have applied almost equally to either form. As M. peasei was widely recognized under its correct name in Island collections, the collectors quite understandably assumed that the remaining similar species must, therefore, be M. langfordi.

A long and careful search through all pertinent literature and many large collections shed no light on the identity of the unknown species. Only one figure seemed to offer a remote possibility in any of the classic works on Mitridae — Sowerby's (1874) figure of Mitra sanguinolenta Lamarck, 1811, somewhat resembled the Hawaiian shell. Mitra sanguinolenta is an almost forgotten species described from a single specimen of unknown locality, discounted by most subsequent authors as probably nonexistent or a synonym of some other species. Notwithstanding the discouraging remarks of Tryon (1882), Reeve (1845), Sowerby (1874), and a few others, on the very slight hope that this might be the same species Lamarck had described, I made inquiries in Paris; these were soon answered with an excellent photograph of the holotype of M. sanguinolenta (see Plate 11, Fig. 2). I should like to express my gratitude to M. Paul-Henri Fischer of the Journal de Conchyliologie for directing my letter of inquiry into the right hands, and to M. J. Gaillard of the Muséum National d'Histoire Naturelle (Paris) for providing the photograph, which establishes without doubt that M. sanguinolenta Lamarck is not the same species that had been mistakenly identified by Hawaiian collectors as M. langfordi.

In April 1962 I had occasion to visit three of the large museum collections on our Atlantic Coast and noted each lot seen that resembled the unknown species; in all the collections of the three museums I was able to find only four lots which I believe to be this species: one lot in the Pease Collection at the Museum of Comparative Zoology (Harvard) labeled "Mitra carnicolor Reeve: Honolulu", and three lots in the United States National Museum (Washington, D. C.) labeled "Mitra clathrus emersoni Pilsbry". The four lots were all collected in Hawaii. As far as I could ascertain, the American Museum of Natural History (New York) has no specimens resembling this form. A personal letter from Miss Virginia Orr (May 1962) establishes that there are likewise no specimens in the collection of the Academy of Natural Sciences of Philadelphia similar to the sample I sent for comparison. I have not seen it in the West Coast collections of the California Academy of Sciences, Stanford University, nor the Los Angeles County Museum. The infrequent occurrence in these large collections not only confirms its rarity but also suggests the possibility of its being an undescribed species and one that may be endemic to Hawaii. Further data for the above and other specimens are included in Table 1.

Kodachromes by TAKEO SUSUKI

Mitra langfordiana J. CATE, spec. nov.

Figure 1: Dorsal Aspect of Paratype 1
Figure 2: Ventral Aspect of Holotype

Table 1

Mitra langfordiana J. CATE, spec. nov.
Data on specimens used in this study. (Measurements in millimeters; depths in feet)

Specimen	In the collection of:	Length	Diam.	Location	Collector & Date	Depth
Holotype	B. P Bishop Museum 215317	25.7	10.1		21 May, 1961	
Paratype 1	Calif. Acad. Sci. Paleo. Type Coll. 12407	25.5	10.4		24 June, 1961	
Paratype 2		25.6	10.1		E. Harrison	
Paratype 3	[1]	16.3	6.9		21 May, 1961	
Paratype 4	[1]	14.4	6.5			
Paratype 5	[1]	6.8	5.5			
Paratype 6		21.9	10.0		Betsy Harrison [2]	45 to 50
Paratype 7	[1]	14.9	6.6	Pokai Bay, Waianae, Oahu	21 May, 1961	
Paratype 8	Mr. and Mrs.	25.8	10.4			
Paratype 9	A. M. Harrison	21.2	8.8			
Paratype 10	[1]	13.2	7.4		E. Harrison	
Paratype 11	[1]	15.6	8.7		11 June, 1961	
Paratype 12	[1]	15.6	7.3			
Paratype 13		21.0	8.4			
Paratype 14		21.7	8.6		Betsy Harrison [3]	
Paratype 15	[1]	17.3	7.4		May, 1961 [3]	50
Paratype 16	J. M. Cate	23.5	9.8		[3]	
Paratype 17		30.4	10.7	Dredged, in coral rubble and sand, Waianae, Oahu	Pele I Expedition 17 April, 1959	100

[1] juvenile [2] fanned in sand [3] fanned out of sand 2 to 3 feet in depth

All of the foregoing left the collectors' questions still unanswered, but after carefully going over all the available information, I have concluded that the shell is a new species, probably endemic to Hawaii. Through the generosity of Elizabeth Harrison, Clifton Weaver, E. R. Cross, Ditlev Thaanum, and John Duarte, I have had the opportunity of studying several specimens of this rare species, and I wish to thank these enthusiastic collectors for their help. Together with the museum specimens mentioned above, I have now seen approximately 37 specimens, a large number indeed for so uncommon a species.

Because I deeply regret that the earlier name honoring D. B. Langford had to be placed in synonymy, and further because collectors in Hawaii have so long associated his name with this particular species (even though incorrectly), it seems fitting to re-establish Langford's name among the Hawaiian Mitridae by using it for this species in a form differing from Pilsbry's original orthography only enough to make the name taxonomically available. It is understood that the name Mitra langfordi now has no standing in molluscan nomenclature. I take pleasure, therefore, in describing this newly recognized Hawaiian mitrid as:

Mitra langfordiana J. CATE, spec. nov.

Shell spindle-shaped, spire longer than aperture; sutures impressed. Protoconch mammillated, homeostrophic, consisting of one or two smooth dark-red whorls (see Plate 11, Fig. 4). Teleoconch of about seven convex whorls, spirally ornamented with regularly spaced pustulose cords, about four or five rows on each upper whorl, 10 or 12 on the last whorl. Space between spiral cords finely grooved with about three parallel ridges and interspaces, of which the central ridge is sometimes slightly more prominent. Shell longitudinally very finely striate, the single striae intersecting all spiral sculpture, creating a beaded effect on the larger spiral cords and forming cancellate sculpture in the interspaces (see Plate 11, Figs. 1, 3, 4).

Aperture straight; labrum in adult specimens fairly thick, smooth within, ridged without by termination of the spiral cords. Columella straight, with two strong oblique adapical folds and from two to three weaker anterior folds. Peristome entire; siphonal fasciole weakly produced, shell very slightly umbilicate.

Basic color of shell beige (Maerz & Paul Dictionary of Color, 2nd Edition, 1950; Pl. 10,

Table 2

Mitra langfordiana J. Cate, spec. nov.

Data on specimens, other than the type series, used in this study. (Measurements in millimeters; depths in feet [*] or fathoms [†])

Specimen	In the collection of:	Length	Diam.	Location	Collector & Date	Depth
Hypotype 1	U. S. N. M. 611285			Old Koloa Landing, Kauai	L. Calves	25 to 30*
Hypotype 2	U. S. N. M. 337978	not measured		Hanokowai, Maui [4]	unknown	2*
Hypotype 3	U. S. N. M. 617617			Pearl and Hermes Reef	Ted Dranga, 1927	
Hypotype 4	M. C. Z. (Harvard)			Honolulu	W. H. Pease	
Hypotype 5	D. Thaanum	24.9	9.3	Pearl and Hermes Reef	D. Thaanum, 1923	
Hypotype 6		36.2	11.9	off Waikiki, Oahu	Thaanum & Langford 1935	20 to 30†
Hypotype 7	C. S. Weaver	34.3	11.9	off Sand Island, Oahu	Pele I Expedition	25†
Hypotype 8		25.5	9.2		summer, 1959	
Hypotype 9	Mr. and Mrs. A. M. Harrison	32.5	12.1	Waikiki, Oahu	E. Harrison, 13 Mar '59	45*
Hypotype 10		37.2	12.8	Haliewa, Oahu [2]	26 June, 1960	15*
Hypotype 11	E. R. Cross	31.6	11.6	off Ala Wai, Oahu	March, 1962	50*
Hypotype 12		25.5	10.1	off Barber's Pt., Oahu	E. R. Cross	
Hypotype 13	[3]	21.4	9.1	in silt and small rubble	May - June,	60*
Hypotype 14	[1]	14.3	6.7	under large coral heads	1961	
Hypotype 15	J. M. Cate	23.5	9.3	Old Koloa Landing, Kauai	John Duarte	30*
Hypotype 16	[1]	15.5	7.1	sand, rubble under coral head	10 August, 1961	
Hypotype 17	J. M. Ostergaard	21.7	8.4	Brown's Camp, Oahu sand	R. M. Gray, June, '56	55*
Hypotype 18	J. M. Cate	20.9	8.4	Oahu; *ex* L. E. Berry coll.	P. Clover	
Hypotype 19		23.2	9.2	Kekala Reef, Kauai, under coral heads	unknown	6*

[1] juvenile [2] fanned in sand [3] decollate [4] in sand, inside reef at very low tide

2D); irregularly mottled and banded with dark brick-red (M & P, Pl. 6, 9K, Havana Rose); spiral cords basically brick-red, pustules on the spiral cords mostly white as if red color is rubbed off on their summits. Aperture soft yellow-beige (M & P, Pl. 10, 3E, Leghorn). Columella and folds in young specimens bright rose-pink (M & P, Pl. 5, 4I, Rose petal) where color band of last whorl is exposed before final coating of inductura is laid down.

The type locality of Mitra langfordiana is Pokai Bay, Waianae, western Oahu, Hawaii (21° 27' N. Latitude, 158° 12' W. Longitude). At the present time M. langfordiana appears to be a species endemic to the Hawaiian Islands, having been collected from Maui in the south to Pearl and Hermes Reef in the north, a range of approximately 20 degrees of longitude and about 7 degrees of latitude, or roughly 1,150 nautical miles. I know of no specimens collected on the island of Hawaii.

The holotype will be deposited in the Bernice P. Bishop Museum, Honolulu, Hawaii, where it will bear the catalogue number 215 317. This specimen and Paratype 1, No. 12 407 in the California Academy of Sciences Paleontology Type Collection were very kindly donated by Mrs. Elizabeth Harrison for use as museum specimens.

Mitra langfordiana differs from M. peasei Dohrn, 1860, in the following ways: it is a coarser, heavier, more obese species with heavily pustulose spiral sculpture, M. peasei having similar spiral ridges also intersected by fine

Explanation of Plate 11

Figures 1 and 3: Typical specimens of *Mitra langfordiana* J. Cate, spec. nov. (approx. x 4)

Figure 2: Holotype of *Mitra sanguinolenta* Lamarck, 1811 (copyright Muséum National d'Histoire Naturelle)

Figure 4: Enlarged photograph showing detail of sculpture and protoconch of *Mitra langfordiana* (approx. x 7.5)

Figure 1

Figure 2

Figure 3

Figure 4

figs. 1, 3, 4, TAKEO SUSUKI, *photo* — fig. 2, © Muséum National d'Histoire Naturelle

axial striae but without pustules. Mitra langfordiana is marked with dark red-brown bands, while M. peasei is buff with slender brown cords and no large color bands. The aperture is creamy yellow in M. langfordiana, white in M. peasei; the columellar folds in M. langfordiana are coarser, and less evenly graduated from large to small than those in M. peasei.

Mitra langfordiana is probably more similar to M. papilio (Link, 1807) (syn. M. sphaerulata Martyn) than to M. peasei, though differing widely from this species in ornament and coloration. Their similarities are chiefly in their general proportions and coarse ornamentation, M. peasei being of a slim, delicate appearance while M. papilio and M. langfordiana share a strong, robust form.

Acknowledgment

I should like to express once again my gratitude to all who helped me with the problems relating to this study; in addition to those already named, without whom it could not have been attempted, I will mention the curators of the various museums where I was privileged to visit in person; Miss Virginia Orr who so promptly furnished the information I needed from ANSP; Dr. Rudolf Stohler who generously translated German literature dealing with Mitra sanguinolenta; and as always, Crawford Cate whose patience and understanding provided a helpful environment in which to work.

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Hybrids between *Cypraea tigris* Linnaeus, 1758 and *Cypraea pantherina* Solander, 1786 (Mollusca : Gastropoda)

BY

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Cypraea tigris Linnaeus, 1758, and C. pantherina Solander, 1786, have been classified as distinct species by all authors; there are many distinctive characters which have been discussed by Schilder & Schilder in 1939 (p. 185). Cypraea tigris lives in the Indo-Pacific Ocean from the coast of East Africa to Polynesia, whereas C. pantherina is restricted to the Red Sea.

Recently we have received from Mr. W. L. Lander, Aden, a series of cowries collected by himself at Aden last year. The series includes both Cypraea tigris and C. pantherina with typical features as well as several intermediate specimens with mixed or intermediate characters: these shells cannot be determined exactly as C. tigris nor as C. pantherina, and they should be regarded as hybrids, we think. Similar intermediates (and true C. pantherina) have been collected, several decades ago, by Major Yerbury also at Aden; they are preserved now in the British Museum (see Schilder & Schilder, 1939, p. 185). A further intermediate shell approaching C. tigris has been collected on the opposite shore of the Gulf of Aden at Jibuti; it is preserved among the duplicates in the Jousseaume Collection (Museum of Paris).

The pale dwarf shells, however, which we have named Cypraea pantherina catulus in 1924 (p. 192) should be classified as C. pantherina according to the present paper, as the holotype only shows some characters recalling C. tigris a little. This variety undoubtedly comes from Aden too, as the holotype and the paratype have been collected by Steindachner and have been given to the author by the late curator of the Museum of Vienna, R. Sturany, in 1920; later on, we have seen three very similar shells also said to come from Aden: two in the Sullioti Collection, Genoa (one of which is now in the writer's collection), and one collected by Yerbury (see above).

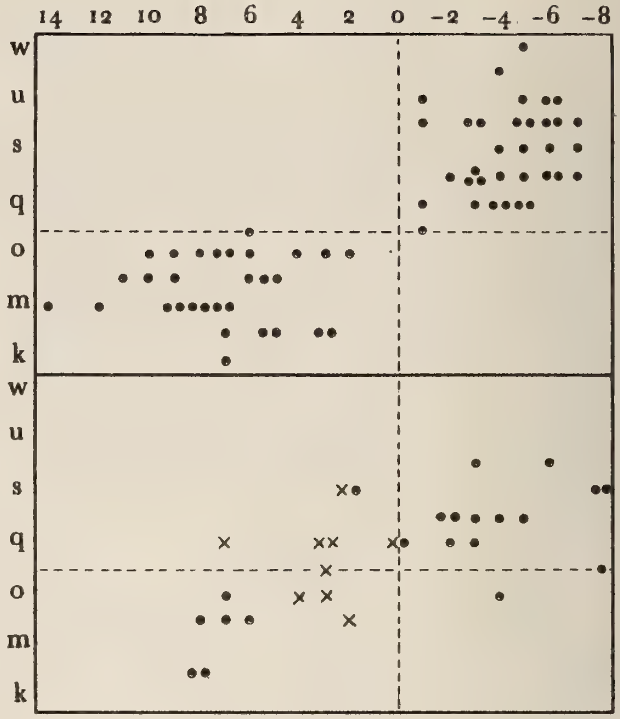
In the present paper we have treated 30 Cypraea tigris from the Western Indian Ocean between Kenya (leg. R. S. Benton), Mozambique (leg. Peters), and the Seychelles (leg. Winckworth), 34 C. pantherina from the Red Sea between Suez and Assab (various collectors), and 30 specimens from the Gulf of Aden, viz. 29 from Aden (leg. Lander, Yerbury) and one from Jibuti (leg. Jousseaume). We have classified the following four most essential characters:

1. The relative breadth of the shell, i. e., the maximum breadth expressed in percent of the length. There is a distinct correlation between this character and the swelling of margins and base: narrow shells exhibit steep margins and flat bases, whereas in broad shells both margins and base are convex. Besides, there is a distinct correlation between the length and the average relative breadth, so that in both species small specimens are usually broader than large ones. The common limit separating most specimens of the broader Cypraea tigris and the slender C. pantherina is about the relative breadth "B" (in percent) in shells of the length "L" (in mm.) as follows:

L	45	50	55	60	65	70	75	80	85	90	95	100
B	70	69	68	67	66	65	64	63	62	61	60	59

Therefore, the corrected relative breadth of each shell can be expressed by a positive or negative figure, indicating the difference between the real relative breadth and the limit between the two species as indicated above.

2. The relative closeness of the columellar teeth expressed by the letters "k" to "w" as explained by Schilder in 1958. The corresponding figures indicating the relative number of columellar teeth in shells of 25 mm. (Schilder & Schilder, 1938, p. 124) have been added in the table below.



The upper half of our diagram shows the correlation between these two characters in 30 Cypraea tigris (left below) and 34 C. pantherina (right above) from the Indian Ocean and from the Red Sea, respectively: there is a distinct gap between the two species. The lower half of the diagram shows the variability of the shells coming from the Gulf of Aden: there is a continuous zone from typical C. tigris to typical C. pantherina, the centres of which seem to be slightly displaced towards the common limit (the crosses indicate specimens believed to be real hybrids).

Additionally, we have examined two more characters evidently independent from the two characters just discussed:

3. The posterior extremity of the inner lip, varying from very blunt to acuminately produced and curved to the left.

4. The size and the color of the lateral spots bordering the base, which vary from large and dark brown to small and pure orange.

In each of these four characters we have distinguished six classes: class 2 and 5 indicate typical Cypraea tigris and C. pantherina, respectively; class 3 and 4 designate intermediate degrees; and class 1 and 6 designate extreme characters. The meaning of the figures is as follows:

Class	Corrected Relative Breadth	Columellar Teeth	Posterior Extremity	Lateral Spots
1	+14 to + 9	k - l (14-15)	Very blunt	Very large, dark
2	+ 8 to + 5	m - n (16)	Rather blunt	Large, dark
3	+ 4 to + 1	o - p (17-18)	Rather acuminate, but straight	Large, partially paler
4	0 to - 2	q - r (19)	Acuminate, slightly impressed on the left	Smaller, brown only
5	- 3 to - 5	s - t (20-21)	Distinctly bent to the left	Small, brownish and orange mixed
6	- 6 to - 8	u - w (22-24)	Extremely produced and bent	Small, orange only

The following list contains the 94 specimens just examined personally, with four figures indicating the classes of the four characters arranged as in this table; in each group the specimens have been enumerated according to the sum of the four figures.

Cypraea tigris from East Africa

Kenya	Mozambique
1211	1212
1221	1232
1221	3142
1222	
1222	
1321	
1321	
2123	
2132	
2132	
2213	
2222	
2222	
2231	
3122	
2142	
2322	Seychelles
2331	2222
2332	2232
3232	2233
3332	2332
3343	2342

Aden Gulf (X = hybrids)

Lander	Yerbury
2122	X 3242
2221	X 3443
2231	X 3345
2133	5455
2322	5455
2233	6555
X 3343	6555 cat.
X 3335	
X 3533	
X 2454	
X 4443	Jibuti
3554	X 3432
4445	
4455	
4455	
4455	C. t. catulus
5455	5346 typ.
5456	6365
5565	6556

Cypraea pantherina from Red Sea

4354	5454
4454	5455
4455	5455
4554	5455
5445	5455
5445	5455

5545	5546	6545	6556
5554	5546	5655	6565
5554	5645	6555	6655
5554	5645	6555	6665
4655	6446		
5456	6455		
5465	6455		

We can plot these figures by pairs:

TYPICAL REGIONS

Teeth \ Breadth	1	2	3	4	5	6
6	-	-	-	1	3	2
5	-	-	-	1	6	5
4	-	-	-	2	10	3
3	2	5	2	1	-	-
2	7	7	1	-	-	-
1	-	4	2	-	-	-

Posterior Extremity \ Spots	1	2	3	4	5	6
6	-	-	-	-	3	-
5	-	-	-	7	13	2
4	-	3	1	-	6	3
3	2	8	1	-	-	-
2	5	7	1	-	-	-
1	1	1	1	-	-	-

ADEN GULF

Teeth \ Breadth	1	2	3	4	5	6
6	-	-	-	-	-	-
5	-	-	2	-	1	3
4	-	1	2	5	4	-
3	-	1	3	-	1	1
2	-	3	1	-	-	-
1	-	2	-	-	-	-

Posterior Extremity \ Spots	1	2	3	4	5	6
6	-	-	-	-	2	-
5	-	-	-	2	8	2
4	-	1	3	-	2	1
3	1	1	3	-	1	-
2	1	2	-	-	-	-
1	-	-	-	-	-	-

One will observe that the figures accumulate in the lower left quarter (Cypraea tigris) and in the upper right quarter (C. pantherina), if we consider the East African and the Red Sea specimens only (the two left tables: the species are separated by the vertical line between class 3 and 4 regarding the breadth and the spots); in the Aden shells (the two right tables), however, there is a uniform band across the table. This fact may be shown both by considering the two characters first indicated (breadth and dentition: the two upper tables) as well as by comparing the two last-named ones (lateral spots and posterior extremity: the two lower tables).

The sum of the four figures designating the four characters of each shell indicates the general tendency of the specimen to approach typical Cypraea tigris (4 x 2 = 8) or C. pantherina (4 x 5 = 20); sums which are outside these limits 8 to 20 indicate specimens with exaggerated specific characters, while sums between 8 and 20 indicate shells intermediate in a more or less distinct way. The following table contains the sums obtained from 30 East African C. tigris (T), 34 C. pantherina from the Red Sea (P), and 30 shells from the Gulf of Aden, separated into true C. tigris (t), true C. pantherina (p), and intermediate shells thought to be hybrids (h):

SUM	T	P	t	p	h
5	1	-	-	-	-
6	3	-	-	-	-
7	4	-	2	-	-
8	10	-	1	-	-
9	4	-	2	-	-
10	5	-	1	-	-
11	2	-	-	-	1
12	-	-	-	-	1
13	1	-	-	-	1
14	-	-	-	-	3
15	-	-	-	-	3
16	-	1	-	-	-
17	-	1	-	2	-
18	-	5	-	4	-
19	-	9	-	3	-
20	-	11	-	2	-
21	-	3	-	3	-
22	-	3	-	1	-
23	-	1	-	-	-

This table confirms that the fauna of Aden contains both species and real intermediates.

Note: Mr. Lander found true Cypraea tigris at Tarshyne Point only, and the hybrids seem to be restricted to the same area, whereas typical C. pantherina have been collected also in remote areas of the Aden region: the material is still too scanty, but it seems to point to the local genetic influence of C. tigris. The dwarf C. pantherina catulus may live in a very restricted place not yet detected by Mr. Lander.

Summary

Cypraea tigris Linnaeus, 1758, and C. pantherina Solander, 1786, are well separable if they come from regions where only one species lives; in the Gulf of Aden, however, where both species occur in the same place, one can observe intermediate shells of various degrees which should be interpreted as hybrids.

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Preliminary Report on Time Elements involved in Hydrotropism in *Helix aspersa* (Gastropoda : Pulmonata) Following Dehydration

BY

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(3 Textfigures)

It has long been known that certain terrestrial animals tend to accumulate either in dry or wet areas. The terrestrial snail Helix aspersa is of the first type. Under dry conditions this animal will go into a state of dormancy, which may be changed to a state of activity upon moistening the animal or upon the introduction of water to its immediate area (Tryon, 1882).

One adaptive mechanism in some animals is a behavioral tendency to select a region of optimum humidity. In arthropods there is an optimal humidity for various species, and such functions as reproductive rate, rate of individual development, proportion of individuals maturing are increased under optimal humidity conditions (Ludwig, 1945). African migratory locusts prefer dry air to wet air (Kennedy, 1937) and a similar preference is found in the mealworm beetle (Gunn and Pielow, 1940). Cockroaches have a mixed reaction to a humidity gradient, but they become more hygropositive when dessicated (Gunn and Cosway, 1938). The wood

louse is active in dry air and becomes almost motionless in nearly saturated air (Gunn, 1937), and Ptinus tectus Boie shows increased locomotor activity with an increase in humidity (Bentley, 1944). In a study of terrestrial isopods it was observed that the animals congregated in moist areas due to a decrease in activity and an increase in turning (Waloff, 1941). Preferences for water - saturated soil and for moist but air-filled soil were observed in some species of earthworms (Roots, 1956). One species of wireworm will migrate from dry to wet soil (Lees, 1943a) and will avoid dry air (Lees, 1943b). A review of the reactions of insects to humidity changes was presented by Dethier and Chadwick (1948).

The following experiments were designed to furnish numerical data concerning hydrotropism in the terrestrial snail Helix aspersa after the animals had been experimentally dehydrated.

Materials & Methods

Three groups of animals were used.

Group I consisted of 130 specimens of Helix aspersa placed in a box $27\frac{1}{2}$ cm. high, 55 cm. long and 40 cm. wide. The top was covered by aluminum screening. The bottom of the box contained about 5 cm. of dry soil, on which food was placed as required. No water was supplied to these animals, nor was the soil moistened at any time. The animals were kept as above from May 12, 1960 to June 9, 1960 by which time all animals had sealed themselves off on the wooden sides of the box.

On June 9, 1960 a round dish with a diameter of 17 cm. and a depth of 4 cm. was filled with water to half its height and placed in the center of the wooden box. A comparable dish without water was placed in the box as a control. It was the purpose of this experiment to determine how long it would take the snails to cease estivating and reach the water. The box and dishes were observed several times each day and night. Snails found at the water dish were marked with blue nail polish on the apex of the spire, thus permitting identification of those snails which had reached the dish. In this manner it was possible to avoid counting the same animal more than once and to permit a count of the total number of animals which reached the water dish during the experimental period.

Group II consisted of 50 snails which were kept dry in a large glass jar until they went into a state of dormancy. The spires of 25 were marked with red nail polish and 25 with blue nail polish and they were then placed in a wooden box 45 cm. by 45 cm., with a height of 4 cm. exclusive of 4 cm. of soil in the bottom of the box. A wooden divider, reaching from the bottom of the box to the aluminum screening covering the top of the box, was placed in its exact center in a manner which would divide the box into halves. A gap of $7\frac{1}{2}$ cm. was left at one end of the divider, giving the snails access from one side of the box to the other through this opening.

One side of the box was left entirely dry and the other half was kept constantly wet. Adequate amounts of food were supplied equally to both sides. The animals with red markings were placed on the dry side in the corner farthest from the passageway between the dry and wet sides; the animals with blue markings were placed on the wet side of the box in the comparable corner. The animals were observed daily and the numbers of red and blue marked snails found on the two sides were recorded. This experiment lasted from May 29, 1960 to June 14, 1960, at which date some animals accidentally escaped from the box.

Group III consisted of 50 animals housed and treated exactly as were the animals in Group II. The only difference between this group and Group II is that after most of the animals had gone over to the wet side, the formerly dry side was made wet and the original wet side was permitted to dry out. This experiment ran from June 15, 1960 to July 4, 1960.

Results

Group I. It was found that approximately 24 hours were required before the first animal ceased being dormant and reached the water dish. Thus the water dish placed in the box at 9 P. M. on June 9, 1960 was reached by the first snail at 9:30 P. M. on June 10. From that time on a successively larger number of snails ceased estivating each day and reached the water dish. Figure 1 shows the day by day increment over a period of 35 days. Most of this activity took place during the hours of darkness. The dry control dish did not attract any animals.

The container in which the Group I animals were housed was too small to permit valid observations concerning the effects of distance from water on the time required to arouse the animals. Within the limits of the space used we observed no differences in time of arousal in animals closer or farther from the water dish.

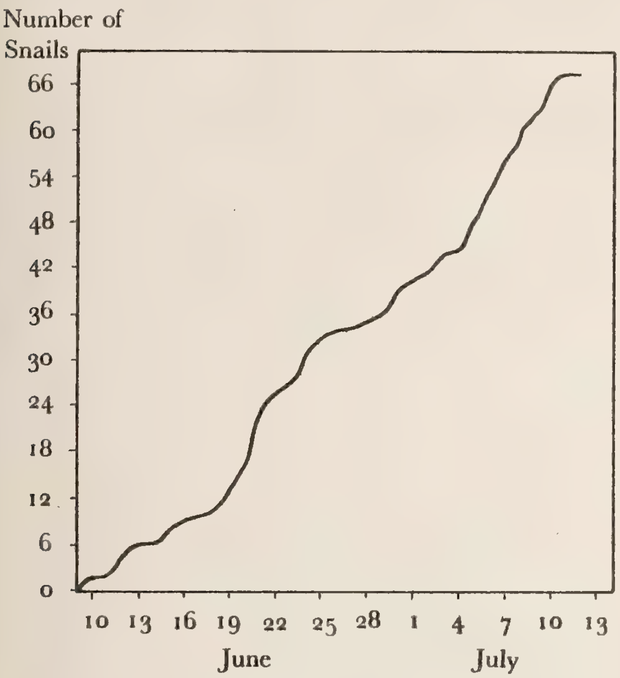

Figure 1: Graph showing the day by day increment in the numbers of animals ceasing estivation and becoming active in the presence of a dish of water (Group 1)

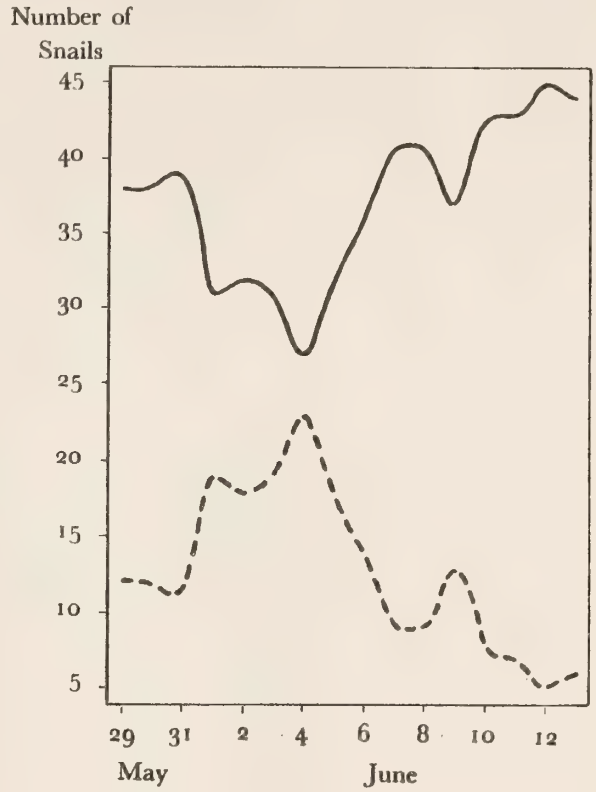

Figure 2: Solid line: number of snails migrating from the dry soil to the wet soil. Broken line: number of snails remaining on the dry side at any given time (Group 2)

Group II. It was observed that the animals from both sides tended to travel back and forth from one side to the other. On the whole, however, the tendency was for all animals, regardless of the side on which they were originally placed, to concentrate on the wet side. The largest number of animals concentrated on each side during each day of the experiment is shown graphically in Figure 2. The initial tendency to move from the dry side to the wet side was observed ten hours after the beginning of the experiment.

Group III. It took ten days for 49 of the 50 animals to concentrate on the wet side. When the wet side was permitted to become dry and the original dry side was made wet it took 9 days for 49 animals to congregate on the new wet side. The largest number of animals concentrated on each side during each day of the experiment is shown graphically in Figure 3. In this group, as in Group II, the tendency to move from the dry side to the wet side was observed within less than 12 hours after the experiment started.

Discussion

It has long been known that Helix aspersa will seek moist areas in preference to dry ones when a choice is available. The mechanism by which this is done is not apparent from these data, but the time intervals involved in ceasing estivation and reaching water are clear. This animal is able to detect moisture from the induced dormant state and will reach the moisture in a short period of time. The behavior of the animal may be experimentally varied by subjecting it to alternate wet and dry environments, and the time required for the beginning of activity and its subsequent continuation may be measured.

The results of these experiments suggest other likely procedures designed to furnish additional data on hydrotropism in Helix aspersa. The effects of relative humidity on the arousal of dormant snails could shed light on the mechanism of arousal. The manner of finding water after arousal could be studied as a possible separate physiologic process. The effect of distance from water on the arousal process will be studied by us in an effort to determine whether a critical distance exists beyond which the presence of water fails to arouse the animals, and to observe any differences existing in arousal time in animals placed at various distances from water within the probable critical distance.

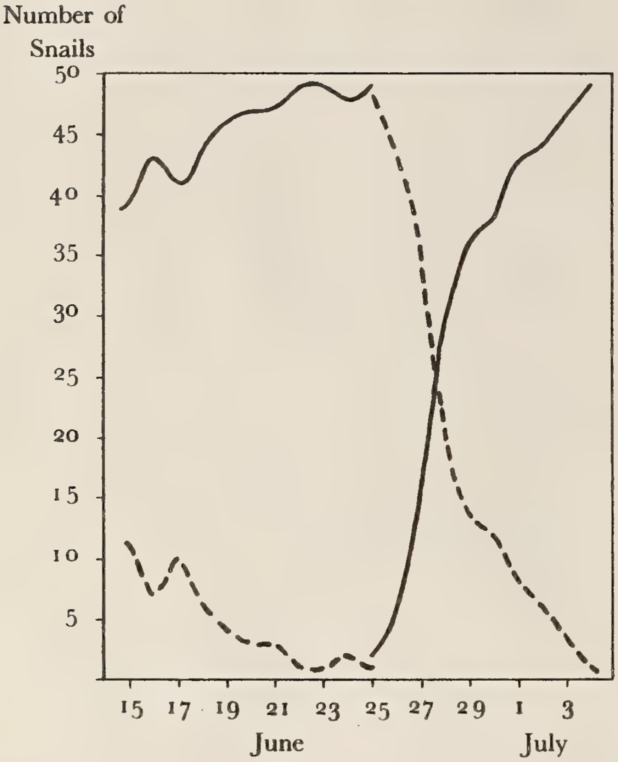

Figure 3: Solid line on the left: number of snails migrating from dry to wet soil. Solid line on the right: number of snails migrating when wet and dry soils were reversed. Broken lines: number of snails on the dry side at any given time (Group 3)

Summary

Three experiments are described in which specimens of Helix aspersa indicated their ability to awaken from an induced dormant state when moisture became available to them. The animals reached moisture within a day after being exposed to its presence.

Animals given a choice between wet and dry soil congregated in the moist area within ten days.

When the positions of wet and dry soil were reversed the animals moved to the new wet soil from the new dry soil within nine days.

ABSTRACT

Two hundred and thirty specimens of Helix aspersa were subjected to three experimental procedures for the purpose of studying their ability to react to the presence of moisture during their dormant state. It was found that it took one day for the first dormant snails to reach water after which time successively larger numbers reached it daily. The first snails left dry soil and reached wet soil in twelve hours or less and virtually all animals in the two groups studied reached wet soil over a period of ten days. When the dry and wet soils were reversed the now non-dormant snails reached the new wet soil in nine days.

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Notes & News

The Types of *Lamellaria sharonae* Willett, 1939 (Gastropoda)

BY

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While going through a large assortment of shells that has been in storage at our home for several years (mostly from the collection of Rubie E. Sharon), we recently came across an important series of West Coast shells, long overlooked because it had never been unwrapped. The shells were in a homemade Riker mount containing three glass-topped pill boxes, each of these holding a pair or more of the probable paratypes of Lamellaria sharonae Willett, 1939. A glance through the dusty glass revealed a pencilled notation on the bottom of the Riker mount itself: "Nautilus of April 1939, page 123. llamaria sharonii" [sic]. Checking this reference we found that the types are in the Los Angeles County Museum (one of these was in alcohol at that time), and "paratypes are in the collections of Mrs. Sharon, and Mr. and Mrs. E. P. Chace." As we purchased Mrs. Sharon's entire collection of shells in 1956, it is probable that these are the above-mentioned paratypes.

We have deposited in museums all eight of the specimens we found, but in so doing we kept two sets intact (with two specimens and four specimens, respectively) rather than disperse all of the shells among eight different repositories, because some of them are subadult specimens. To the best of our knowledge, the entire known series of type specimens of Lamellaria sharonae Willett, 1939, is listed here, together with the location of each set:

Los Angeles County Museum:	
Holotype	LAM 1059
2 Paratypes	LAM 1124
	LAM 1125
San Diego Natural History Museum (ex Chace Coll.):	
2 Paratypes	42'596
United States National Museum:	
4 Paratypes	638'944
California Academy of Sciences:	
2 Paratypes	12'406
Santa Barbara Museum of Natural History (replaces paratype lost by fire in 1962):	
1 Paratype	03'606
Stanford University Paleontological Type Collection:	
1 Paratype	9'514

According to Willett's original description in The Nautilus (1939), the Sharon specimens were collected in Anaheim Bay; the Chace specimens he designated as paratypes are from Newport Bay. Willett's spelling ("sharoni") was emended by Burch (1946) to the correct form as used here, because the species was named for Mrs. Sharon.

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1963 Meeting Dates of the American Malacological Union

Pacific Division

The 16th annual conference of the American Malacological Union, Pacific Division, will once again be held on the beautiful campus of the University of California at Santa Barbara (Goleta). The dates will be June 26, 27, 28, and 29, 1963. Be sure to reserve these dates well in advance, as you will not want to miss this meeting! Well-known collectors from overseas are planning to attend and will share some of their experiences with us.

Further details regarding reservations and program will be announced later.

Crawford N. Cate, Chairman
A. M. U. - P. D.

Notes on Some Tropical West American Mollusks

BY

EUGENE COAN

Conchological Club of Southern California
Los Angeles 7, California

The following are specimens with which I have recently worked and which constitute new records to be reported. All were collected during my trip to Mazatlán in December, 1961, except for Gastrochaena ecuadoriensis.

1. Clathurella rava (Hinds, 1843); one specimen. Rubble beach on the north end of Mazatlán. Previously known from Nicaragua to Costa Rica.

2. Nassarius limacinus (Dall, 1917); one specimen. Material deposited on the ocean side of the northern portion of the Mazatlán breakwater. Not taken since its description.

3. Aesopus xenicus Pilsbry & Lowe, 1932; two specimens. Mazatlán, with Nassarius limacinus. Previously known from Acapulco.

4. Mitromorpha filosa Carpenter, 1865; one specimen. Mazatlán, with Nassarius limacinus. Gale Sphon and Faye Howard collected three living specimens on Venado Island, Mazatlán, in the same month. Dall (1921) reports it from the "Gulf of California" in Bulletin 112.

5. Semelina sp. cf. S. subquadrata (Carpenter, 1857); many valves. Mazatlán, with Nassarius limacinus and others, from dredgings that had been dumped on the south shore of Mazatlán Harbor. This seems to be the S. subquadrata of Olsson (1961). It is not certain whether these specimens are the "? Montacuta subquadrata" described by Carpenter (1857). Keen (1958) reports that Hertlein and Strong have identified a Mysella subquadrata as being what Carpenter meant. Type specimens will have to be studied before the discrepancy can be cleared up. Carpenter's description seems to fit Semelina.

6. Petricola (Rupellaria) exarata (Carpenter, 1857); 10 complete specimens. Nestling in rocks just south of the buildings of Altata. Carpenter's description was based upon an evidently immature specimen, and the form seems not to have been taken since.

7. Gastrochaena sp. cf. G. rugulosa Sowerby, 1834; many perfect specimens, which seem to be this form, were collected at Altata, with Petricola exarata. One specimen was collected boring in Vitularia salebrosa in Bocochibampo Bay, Guaymas. This extends the range from the Galápagos Islands. Specimens in the Stanford collection extend the range to Scammon's Lagoon. Shells identified as Spengleria truncata (Sowerby, 1834) by collectors may also be this species.

8. Gastrochaena ecuadoriensis Olsson, 1961; one perfect specimen, out of a valve of Anadara multicostata beached near Guaymas. Collected in March, 1961, by Joseph Magruder. This extends the range from Ecuador.

Acknowledgment

The identifications of the first three species were made with the assistance of Dr. S. S. Berry; Dr. Myra Keen identified the next four species listed; Dr. Leo Hertlein identified the last. I wish to express my gratitude to the persons named.

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Carpenter, Philip Pearsall
1855/57. Catalogue of the Reigen collection of Mazatlan mollusca in the British Museum. xvi + 552 pp. Warrington.

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1961. Mollusks of the tropical eastern Pacific, particularly from the southern half of the Panamic Pacific faunal province (Panama to Peru). Part I. Panamic-Pacific pelecypoda. Paleont. Res. Inst. Ithaca, N. Y.; pp. 1-574; pls. 1-86.

New Officers of the American Malacological Union

Pacific Division

At the business session of the American Malacological Union, Pacific Division, meeting for its 15th convention at Asilomar on June 30, 1962, the following persons were elected to serve during the 16th convention:

Crawford N. Cate, Chairman (Los Angeles)
Dr. A. Myra Keen, Vice-Chairman (Stanford University)
Ruth Chace French, Secretary (Lomita)
Fay Henry Wolfson, Treasurer (San Diego)

Cowrie Holotype Located

BY

CRAWFORD N. CATE

Conchological Club of Southern California
Los Angeles 7, California

Miss J. Hope Macpherson has very kindly pointed out the whereabouts of the holotype of the subspecies named Cypraea venusta bakeri Gatliff, 1916, mentioned in my recent paper (July, 1962) as unknown. According to Miss Macpherson this specimen is Number F616 in the collection of the National Museum of Victoria in Melbourne, Australia, where she is Curator of Molluscs. I am grateful for the opportunity to add this bit of information to the other facts known about this rare cowrie.

The Editor's Face is RED!

The Editor apologizes. A glaring error was permitted to pass by, unnoticed for the time! In the title of Mr. Lance's first article in our July issue, it should, of course, read: from the Northeastern Pacific. The same correction should be made in the title given on the inside portion of the table of contents.

Information Desk

Use of the Term "Hypotype"

BY

R. TUCKER ABBOTT

Academy of Natural Sciences of Philadelphia

(Editor's Note: The following article was sent in by Dr. R. Tucker Abbott. As is customary with all papers received for publication in the Veliger, it was submitted to members of the Editorial Board for appraisal and comment. The members of the Editorial Board either did not agree with Dr. Abbott's paper in its entirety or with large portions of it. Consequently, the paper was returned together with the written comments by one member, in order that he might modify such portions as seemed open to criticism; in particular, it was suggested that he should indicate that this represented his personal opinion. Dr. Abbott resubmitted the paper unaltered, indicating that he did not think it desirable - in his words - to "belabor such a short and not overly important article with numerous phrases of 'in the opinion of this author' .. etc." We are, therefore, publishing his paper exactly as originally submitted. Needless to say, we cannot agree with Dr. Abbott in all points but he certainly has the right to be heard. — Dr. Abbott's article will be followed by the comments Dr. Keen had made and which she has kindly consented for us to include here.)

The use of the term "hypotype" by the editor of and by many authors writing for The Veliger is not the customary one used among practicing taxonomists, and is therefore in need of clarification. Contrary to Stohler's understanding (1962, p. 217), primary types include neotypes and lectotypes, but not hypotypes. The latter are secondary types (Frizzell, 1933, p. 664). The use of the term "hypotype" as a partial substitute for "paratype" or complete substitute for the term "paratype allotype" is neither warranted nor correct.

Most definitions, including the original by Schuchert (1897), and subsequent ones by authors of books on procedures in taxonomy (Schenk & McMasters, 1936, and Keen & Müller's 1956 edition; Mayr, Linsley, & Usinger, 1953; Frizzell, 1953, p. 152; Int. Code Zool. Nomen., 1961, p. 75 and p. 79, recomm. 73D) state, or imply, that "paratypes" include all of the type-series, other than the holotype {see also Editor's Comment at the end of this article}. That some specimens examined and used by the describer came from localities other than that of the holotype or the type locality has never limited or changed the definition of a "paratype" in the minds of these authors or the International Commission.

The relative value of paratypes from the type locality as contrasted with those from different localities is not as significant as one might suppose, for "mixtures" of species among paratypes can occur among any sampling, regardless of where or when it was collected. Nevertheless, this fine distinction was recognized and given names by Silvestri in 1929. The terms are clumsy and have been abandoned by most workers ("paratype allotype" — a paratype from a different locality than the holotype; paratype omotype" — a paratype from the same locality as the holotype). In practice, one need only read the locality data on a label or in the text- or figure-reference of a paratype to determine to which category it belongs.

The term "hypotype" introduced by Schuchert (1897, p. 637) is what some paleontologists once called the "Supplementär-type", "supplementary type", or Cossmann's "Plesiotype". This was a specimen subsequently described or figured in a later publication which extended or corrected the knowledge of a previously defined species. For example, if the holotype was a fossil fragment or a poorly preserved specimen, a second, better, and subsequently-collected and -illustrated specimen was termed and designated the "hypotype", a sort of "improved" holotype. In practice, this term lost its usefulness, for any specimen subsequently figured or better described became a hypotype. Thus, hundreds of specimens of species originally described by Linnaeus became so-called hypotypes. For one example of this practice, see Hertlein & Emerson, 1953, p. 362. In due course, some workers used "hypotype" in lieu of "a figured specimen".

A genus was illustrated and a hypotype of it established by Durham (1944, p. 192, Sepia? sp., hypotype no. 35501, Mus. Paleo., Univ. Calif.) when the intent was merely to indicate that the specimen of an unidentifiable fragment was being illustrated in his paper.

A still different use of the term "hypotype" was introduced into the literature in 1959 by Stohler in describing his Macrarene coronadensis. It was applied to specimens in the type-series, but this was an incorrect usage of Schuchert's term. The terms "hypotype" and "homeotype" are largely obsolete and have little use. If the use of the term "hypotype" continues as a partial substitute for "paratype", one will have to coin a new term to distinguish a "hypotype that was part of the type-series" and a "hypotype that was published upon in a paper appearing after the original description". In the event that a holotype was lost or destroyed, only a "hypotype" from the original type-series could be chosen as a lectotype, while a "hypotype" of the customary understanding would have to be made a neotype.

The most useful terms for species types which have survived and are recommended by most experts are: holotype, paratype, syntype, lectotype, neotype, and topotype. The other 230-odd type-terms usually can be expressed in plain English.

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1959. Two new species of west North American marine gastropods. Proc. Calif. Acad. Sci., 4th ser. 29: 423-44; figs. 1-10.

——, ——
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(Editor's Comment: The new Code governs the naming of species and certain other taxa in the interests of stability and universality. The Code does not attempt to regulate the thinking of investigators; in fact, much emphasis is laid in the introduction to the new "International Code" that the opinions and decisions of the individual workers should remain unhampered and uninfluenced by the Code, except in the matters strictly pertaining to the naming of taxa. Dr. Abbott refers above to Article 73, recommendation D. In the language of the Code a recommendation is just that; it is not mandatory. However, Article 72 (b) is binding. It reads as follows: "Article 72. General provisions. - (b) Type-series. -- The type-series of a species consists of all the specimens on which its author bases the species, except any that he refers to as variants, or doubtfully associates with the nominal species, or expressly excludes from it."

This article seems clearly to authorize an investigator to use in his original description material from any source. For reasons discussed in our paper (Stohler, 1959), we had

chosen not to include as paratypes certain specimens; yet we felt the need to distinguish those other specimens in a special way. We are aware that curators of certain museums to whom we distributed our hypotypes have entered them as paratypes. This is, of course, their prerogative, as long as the original label, supplied with the specimen, remains with it. The reasons for setting apart the hypotypes, as used in the paper mentioned, were more fully elaborated in the other paper to which Dr. Abbott takes exception (Stohler, 1962). It is only one of the three uses of the term 'hypotype' to which Dr. Abbott objects, but it is the one in which we are directly involved.)

COMMENTS ON A PAPER BY R. T. ABBOTT

by Myra Keen

{This commentary by Dr. Keen was made by her as a member of the Editorial Board and is published with her permission.}

The terms "primary" and "secondary" were used in Schenk & McMasters' work to classify type terms by function, purely as a matter of convenience for students. This publication was not official and certainly did not preëmpt the use of the two words for other ways of grouping. In The Veliger paper of Stohler (Vol. 4, No. 4, p. 217), the grouping of type terms is in a temporal sense: primary, first; secondary, later. I cannot see that Dr. Stohler is in error if he chooses to do this. His critic may think he is, but this is a different matter. Most of the sentences in the first paragraph of his paper should be prefaced with "I think" or "I believe", for they all (or nearly all) express personal opinion that is not necessarily based upon objective evidence.

It is true that the term "hypotype" was originally proposed in a rather restricted sense. This does not mean that in practice its use may not be broadened. I suspect that I have been one of the prime culprits in so doing, for it is the conviction at Stanford that type categories should be as few as possible. Our printed labels carry only the headings: holotype, paratype, syntype, neotype, lectotype, and hypotype. Any specimens that do not qualify for one of the first five categories must of necessity fall into the sixth. This is a purely practical consideration, aside from theory.

As to the objection to a restricted usage of "paratype". It is a logical corollary of the newer trend in zoology, regarding types as mere population samples. The type series should represent a single population as nearly as the author of the species can recognize it. If he includes material from unknown or distant localities, he increases the risk of creating a composite species that will later have to be refined. From this viewpoint, it would seem more discreet to restrict the type series to that population at the type locality and to designate other material as supplementary or as extending the concept of the species — in other words, as hypotypes, even though the author may feel confident of his identification. The new International Code makes no provision at all for the category of hypotype, and paratypes are relegated to a Recommendation, in which authors are advised to label them as such after selecting the holotype. To me this means that we are free to derive, pragmatically, procedures that will insure a maximum of clarity and a minimum of later revisionary work. It would seem to be safer to err in the direction of under-inclusion than of over-inclusion in the type series and to consider that specimens separated from each other, either in time or space, by an appreciable gap are not members of a single population, even though they may be a part of a species unit.

The Disposition of Type Specimens

BY

RUDOLF STOHLER

Department of Zoology
University of California, Berkeley 4, California

Any holotype, being the name bearer of a species or subspecies, should be regarded as public property since it should be available to all qualified workers who need to refer to it. This availability should never be limited, as it would be if the type specimen were to remain in private hands. Logically, then, the holotype specimen should be deposited with some recognized public museum that is prepared to care for such material on a permanent and continuing basis.

Paratype specimens, especially if relatively numerous, might be distributed to a number of widely scattered public museums. This would have the advantage that workers in distant

places would have relatively easy access to a typical representative of a given taxon. However, in view of the trend toward considering species units on a population level rather than on a single specimen level, it can be argued that it would be much more advisable to keep the entire group of specimens, upon which the new taxon is based, together. This argument receives added support from the possibility that the original population might have been composed of two or more sibling species and to ascertain this possibility the entire population would be needed; if the specimens were widely distributed, the task becomes almost hopeless, for the re-assembling of the group in one place may not be feasible.

However, if the author desires to distribute his specimens, he certainly has the right to do so. In that case he should consider not only the distribution of the specimens but also the location of the workers in the same or closely related field. Further, some paratypes should be placed in public museums that are fairly close to the type locality, so that local collectors might compare their own specimens with a type specimen for positive identification. But the author should not feel obliged to give paratype specimens to private individuals, especially if they have not made arrangements for ultimate placement of their collection in some properly qualified public repository. It was pointed out in an earlier article of this series that paratypes may become of utmost importance if the holotype specimen, for one reason or another, is lost or destroyed. One of the paratypes then will be chosen to become the lectotype. If all paratypes are in private collections, it will be difficult, if not impossible, to select a lectotype, especially if no records have been kept of the whereabouts of the paratypes or of the fate of the private collections containing them. Too often, private collections become lost or hopelessly scattered after the death of the original owner.

The importance of the ready availability of the holotype is so great that no journal should accept a manuscript in which a new taxon is described unless definite and binding provisions have been made to deposit at least the holotype with a recognized public museum. At the same time the museum number assigned to the holotype should be included in the publication, as this will materially facilitate locating the holotype if it ever becomes necessary. The policy of The Veliger has been from its beginning to make these conditions, and we are gratified to see other reputable journals gradually adopting the same policy.

Another point to consider is the most appropriate time for the type material to be turned over to the repository. A serious problem may arise in those cases where curators have adopted the policy of assigning museum numbers only upon receipt of a specimen. This has some advantages for the museum but has dangers inherent for the author of a new taxon. We consider it unwise to relinquish the type material before the description of the new taxon is actually published, yet it is very important that the museum number of the types of the new taxon be recorded at the time of its original publication (so that future workers would have that information without delay). If a specimen is transmitted to a repository before publication, there is the danger that a visitor to the collection may unwittingly make a nomen nudum of the name; it is possible that he might, in good faith, report in some club publication that he had seen the type of taxon "A". In most cases, unfortunately, there is a considerable lapse of time between the acceptance of a manuscript and its appearance in print. Even a cautious curator might forget that the specimen in his care represents an as yet unpublished taxon. Since the human element cannot ever be ruled out, we strongly favor withholding the type specimens — and even the use of the name in correspondence — until publication is complete.

The acceptance of type material, however, implies also the acceptance of certain obligations by the repository. Since the holotype may be regarded as public property — that is to say, available for inspection to any and all interested and duly qualified workers — the museum must be prepared to do several things. First and foremost must be the assurance that the specimen will be properly preserved in such a fashion that its natural colors are protected as much as possible; that the specimen itself be kept free from attacks by pests of any sort; that specimens preserved in liquids be kept from drying out. The second condition must be that the museum is prepared to accommodate visiting workers so that they can study the type material in every way that may be necessary. And thirdly, the repository should be in a position to supply promptly detailed information about the type specimens in its care; photographs should be made available, if requested. Of course, it is only fair that the museum supplying such information be reimbursed for its own costs and that its rights in its photographs or other illustrative material be protected. However, if a museum refuses to cooperate with workers making reasonable requests, no further donations of type material should be made to such

an institution. If the lack of cooperation is due to poor housekeeping on the part of the curatorial staff, that is, if the type specimens have become lost or so badly misplaced as not to be readily available, it is obvious that one of the fundamental requirements for a type repository is not being met. If a museum decides on a reorganization of its collections, information on type material should still be made available, since the fact of past poor housekeeping at a particular institution should not be permitted to hold up or delay current research work. Such a museum runs the risk of alienating donors who may remove it from the list of recipients until it again is in a position to render those services to be justifiedly expected from it.

There is a tremendous task ahead for the staffs of many type repositories. In recent years several lists and books have been published in which the exact whereabouts of type specimens is listed; many of these lists, such as the one by Dr. K. V. W. Palmer on the Carpenter types, not only fully illustrate the type specimens but also contain important critical revisions of the species for which the types are present. Such lists are of utmost importance and it is to be hoped that eventually all existing type specimens will be reported. The minimal information to be supplied should include the place where the specimen is kept, its museum number, its state of preservation, the exact spelling of the name given by the original author. Additional information might include the usual measurements for that kind of animal, made with accurate modern measuring instruments and given in metric units; it might include a complete synonymy for the particular taxon, but at least the name under which the taxon is known at the present time; and certainly not least desirable would be adequate illustrations of the type specimens.

Books, Periodicals, Pamphlets

THE GENUS TUBUAIA (PULMONATA, ACHATINELLIDAE)

by Yoshio Kondo

Bernice P. Bishop Museum Bull. 224, pp. 1-49, figs. 1-14, February 16, 1962.

This is a continuation of the work initiated by Cooke & Kondo's 1960 "Revision of Tornatellinidae and Achatinellidae", previously reviewed in The Veliger (Vol. 4, No. 2, pp. 116-117), in which Tubuaia was proposed as a new genus of achatinellids. This present paper deals with 18 species of the genus of which 10 species, 11 subspecies, and one variety are new. Material is based mainly upon shells collected by the Mangarevan Expedition of 1934. Distribution of these land snails is limited only to certain Pacific Islands, including the Cook, Society, and Austral groups, and Rapa, Mangareva, Pitcairn, and Henderson. An outlier species is found on the Kermadec Islands. The work is typical of Kondo's thorough work and the illustrations are his own excellent drawings. The evolution and zoogeography of the group are interestingly discussed, along with possible methods of distribution.

AGS

MARINE MOLLUSCS OF VICTORIA

by J. Hope Macpherson and C. J. Gabriel

Melbourne University Press, 475 pp., 500 illust., cloth bound. 1962. Sold in the United States by Cambridge University Press; price will be about $12.-.

Detailed descriptions and illustrations cover all of the common species of Victorian shells, together with their range and distribution. Their points of difference are stated simply, and any feature of special interest is discussed, so identification is made easy. A systematic list of the remaining species is given with their authors and recorded Victorian localities. There is a definition of each family and of the principal genera, including the author of the genus and type species. All scientific names

are given with dates and a comprehensive bibliography. A very good glossary explains the technical terms used in the scientific descriptions. This is of value not only to the layman but to the advanced student, because authors differ in their terminology. The index is adequate. This is important; we have too many books that contain valuable information but with an index so poor that the reader cannot find it. This is a scholarly book and highly recommended.

JQB

HOW TO KNOW THE EASTERN LAND SNAILS

by John B. Burch

Pictured Key Nature Series (H. E. Jaques, Ed.); 214 pp., 519 figs. in text; Wm. C. Brown Company, Publishers, 135 South Locust St., Dubuque, Iowa. 1962 (Recd. June). $2.50.

This newest addition to "The Pictured Key Nature Series" which was started in 1947 is a most welcome addition to conchological literature. Basically, it is a manual for identification of species east of the Continental Divide in the form of a carefully constructed key that expert and amateur alike will find relatively easy to use. Of special importance is the fact that each species is illustrated with drawings made by the author in most instances, many of the smaller snails being enlarged to show salient characters of shape and sculpture. An added feature is the careful explanation of the terminology used in the key by means of applicable drawings. The first few sections describe the snails and their basic morphology, the systematics of the Mollusca in general, with emphasis on the gastropods, the various molluscan provinces in the United States, habits of snails and slugs, and their economic importance. There is a well selected list of references. Following these sections is a pictured-key to land snail families that the interested beginner will need to use as a first step in identifying species, which are keyed to their respective families. This paper-backed guide closes with a systematic list of the eastern United States land snails, including page and figure references, and an excellent "Index and Pictured Glossary".

Burch, who is a Research Associate in the Mollusk Division, Museum of Zoology, University of Michigan, is to be highly complimented for a thorough and painstaking technical piece of work that will serve for a long time as a useful guide to eastern land snails. His classification follows Pilsbry's monumental work on the "Land Mollusca of North America (North of Mexico) 1939-1948", which is expensive and too bulky to carry in the field. Burch's Pictured-Key happily is both handy and inexpensive. This reviewer has already used the Key several times on species generally difficult to identify and has found that it works. The only seeming flaw observed is the appearance of the polygyrid species Mesodon roemeri (Pfeiffer) in three different positions in the Key (pp. 163, 170, 172). Species of the Succineidae, or "amber snails", are covered by generic examples only, because present taxonomic difficulties prevent proper identification of the 20 or more eastern United States species. A few of the species illustrations, notably of the Helicidae, are not up to the high standards set by the great majority.

This guide paves the way for a similar one covering species west of the Continental Divide, which has long been a desideratum for West Coast conchologists.

AGS

NEW AND LITTLE-KNOWN SPECIES OF SOUTH AND CENTRAL AMERICAN LAND SNAILS (BULIMULIDAE)

by Juan José Parodiz

Proceedings, U. S. National Museum, vol. 113, no. 3462, pp. 429-456, pls. 1-2. 1962. (Recd. July)

A relatively short but important taxonomic paper on a large land snail family, based upon an examination of about 1,000 species in the National Museum collection. A total of 46 species or subspecies are discussed, including eight described as new. Dr. Parodiz, Curator of Invertebrates, Carnegie Museum, Pittsburgh, Pa., is working on a needed reclassification of the Bulimulidae to be published in a more extensive paper which will be welcomed by students of this interesting group of land snails.

AGS

REPORTS
OF THE LUND UNIVERSITY
CHILE EXPEDITION 1948-1949.
35. PELECYPODA

by Tron Soot-Ryen

Lunds Universitets Arsskrift N. F. Avd. 2, Bd. 55, Nr. 56 (Kungl. Fysiografiska Sallskapets Handlingar. N. F. Bd. 70, Nr. 6), pp. 1-86, pls. 1-4, figs. 1-6 in text. 1959.

This contribution to the knowledge of Chilean mollusks contains the results of a study of the Pelecypoda (67 marine and two freshwater species) collected on the Lund University Chile Expedition. These were assembled from 118 collecting stations, from shore to 470 meters, but mostly not exceeding 50 meters. Combined with the species of this expedition are earlier records of pelecypods from Chile, making a total of 167 species arranged in 46 families.

Of the total number, 80 species are endemic; 35 occur in the Atlantic; and 56, about a third of the total fauna, range to the north of Chile to Peru or further. There are 95 genera, none endemic, 53 of which are represented by only one species. A remarkably large number of species of Nucula (22) have been reported from Chile; but Soot-Ryen pointed out that some of these are synonyms and some incorrectly identified.

The Magellanic region has the highest number of species, 96 (57.5 percent) of the total fauna, also the highest percentage of Prionodesmacea (38 of 52 or 73 percent), and Anomalodesmacea (11 of 13 or 85 percent). The Teleodesmacea occur in greatest number in northern Chile (56 of 102 or 55 percent).

The antiboreal region is divided by Soot-Ryen into the Magellanic and a minor Chonos zone which extends north to Chiloe Island. Thirty-three species are endemic to the Magellanic fauna, and the same number occur in the western Atlantic. Between Chiloe Island and Valparaiso, the Magellanic zone gives way to a temperate subzone. Just north of Valparaiso this temperate zone is replaced by a warm temperate zone characterized by 34 species, 11 of which are endemic.

Soot-Ryen, from his studies, concluded that the affinities of the species of the Magellanic fauna with those of the Antarctic are negligible. However, the genera of the Chilean pelecypod fauna, other than those of wide distribution, show close relationship with those of the eastern and western Americas and the Antarctic, although some point toward faunal relationship with the subantarctic islands, Australia, New Zealand, and South Africa.

Twenty-one species are illustrated on four plates. Nine species described as new in 1957 (Astarte, No. 16), illustrated in the present paper are: Malletiella soror (pl. 1, figs. 4-5), Philobrya brattstroemi (pl. 1, fig. 6), Lyonsia elegantula (pl. 1, fig. 10), Kingiella chilenica (pl. 2, figs. 13-15), Cyamiocardium dahli (pl. 2, fig. 16), Neolepton hupei (pl. 2, fig. 18, textfig. 3), Lasaea helenae (pl. 2, fig. 21), Mysella sculpta (textfig. 5), and Chione (Nioche) keenae (pl. 3, figs. 24-25). Additional species, not previously illustrated, include Chlamys amandi Hertlein and Lasaea petitiana Recluz.

This very useful paper, in addition to the systematic discussion, contains zoogeographical remarks, a summary in English and in the Spanish language, and an alphabetical list of genera and subgenera.

LGH

TROCHUS OBTUSA CONFUSION

by J. Hope Macpherson
Curator of Molluscs,
National Museum of Victoria

Memoirs of the National Museum, Melbourne, No. 25. May 1, 1962.

In this brief but very thorough paper, Miss Macpherson proposes the name Chrysostoma obtusa (Dillwyn, 1817) for Trochus obtusus Dillwyn, 1817. Also, for the preoccupied Murex espinosus Macpherson, 1959, she proposes the substitute name Murex tweedianus Macpherson, 1962.

RS

SHELLS OF NEW ZEALAND

by A. W. B. Powell

Whitcombe & Tombs, Ltd., New Zealand. August 1962. About $2.80 (price in the United States probably $4.- ppd.).

The 1957 edition contained 202 pages, 530 illustrations of species, and a complete check-

list to that date of all of the living mollusks of New Zealand. The 1962 revised version includes marine, freshwater, and land mollusks. An important feature of this later edition is that it contains references to the literature with dates of all species. This is a scholarly work and recommended to all serious students.

JQB

COMMON SEASHORE LIFE OF THE PACIFIC NORTHWEST

by Lynwood Smith

Vinson Brown, editor; Naturegraph Company (Healdsburg, California). Vol. 2, Naturegraph Ocean Guidebooks; 66 pp., soft cover, illustrated. 1962.

This is a companion to Volume 1 of the Naturegraph Ocean Guidebooks "Common Seashore Life of Southern California", by Joel Hedgpeth and Sam Hinton, reviewed in the July 1, 1962, issue of The Veliger. Volume 2 covers the common elements of marine life to be found from Mendocino County, California, to British Columbia and Vancouver Island. Like its predecessor it contains much useful and interesting information and many drawings, with 11 photos in color; but unlike it, unfortunately, Volume 2 fails to measure up in many respects to the excellent standards set in Volume 1. In particular, the drawings of marine species are amateurish; in some instances they are so unlike the actual animal or shell that they cannot help but contribute to confusion rather than to enlightenment. It is to be regretted that the seashore life of the Pacific Northwest, which is rich and varied, could not have had better treatment in a much-needed guidebook.

AGS

PROCEEDINGS OF THE MALACOLOGICAL SOCIETY OF LONDON

Vol. 35, Part 1, April 1962.

E. P. Hodgkin: Patelloida profunda (Deshayes) from Mauritius.

J. H. McLean: Feeding Behaviour of the chiton Placiphorella.

MK

BIOLOGICAL PECULIARITIES OF THE FAR EASTERN MOLLUSK SCHIZOPLAX BRANDTII (MIDDENDORFF)

by O. G. Kussakin
Zoological Institute
USSR Academy of Sciences (Leningrad)

Zoological Journal, Academy of Sciences of the USSR, tom. 39, no. 8, pp. 1145-1150, figs. 1-2, 1960. [In Russian with a brief English abstract.]

AGS

SOME PRINCIPLES OF DISTRIBUTION OF THE FAUNA AND FLORA OF DESSICATION ZONES IN THE SOUTH KURILE ISLANDS

by O. G. Kussakin
Zoological Institute
USSR Academy of Sciences (Leningrad)

Research in the Far Eastern Seas of the USSR, 7, pp. 312-343, figs. 1-3, tables 1-5, 1961. [In Russian; no English summary; deals with intertidal zonation.]

AGS

THE VELIGER is open to original papers pertaining to any problem concerned with mollusks.

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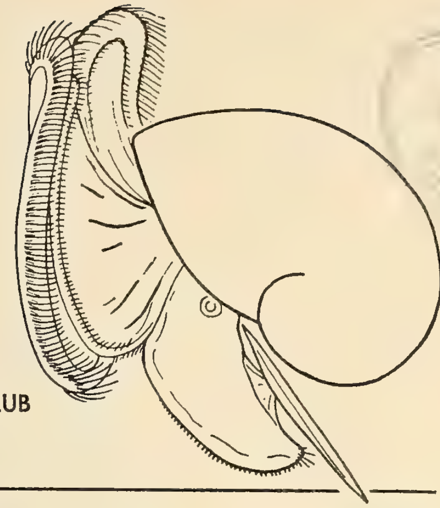
Short articles containing descriptions of new species or lesser taxa will be given preferential treatment in the speed of publication provided that arrangements have been made by the author for depositing the holotype with a recognized public Museum. Museum numbers of the type specimens must be included in the manuscript. Type localities must be defined as accurately as possible, with geographical longitudes and latitudes added.

Short original papers, not exceeding 500 words, will be published in the column "NOTES & NEWS"; in this column will also appear notices of meetings of the American Malacological Union, as well as news items which are deemed of interest to our subscribers in general. Articles on "METHODS & TECHNIQUES" will be considered for publication in another column, provided that the information is complete and techniques and methods are capable of duplication by anyone carefully following the description given. Such articles should be mainly original and deal with collecting, preparing, maintaining, studying, photographing, etc., of mollusks or other invertebrates. A third column, entitled "INFORMATION DESK," will contain articles dealing with any problem pertaining to collecting, identifying, etc., in short, problems encountered by our readers. In contrast to other contributions, articles in this column do not necessarily contain new and original materials. Questions to the editor, which can be answered in this column, are invited. The column "BOOKS, PERIODICALS, PAMPHLETS" will attempt to bring reviews of new publications to the attention of our readers. Also, new timely articles may be listed by title only, if this is deemed expedient.

Manuscripts should be typed in final form on a high grade white paper, 8½″ by 11″, double spaced and accompanied by a carbon copy.

THE VELIGER



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CONTENTS

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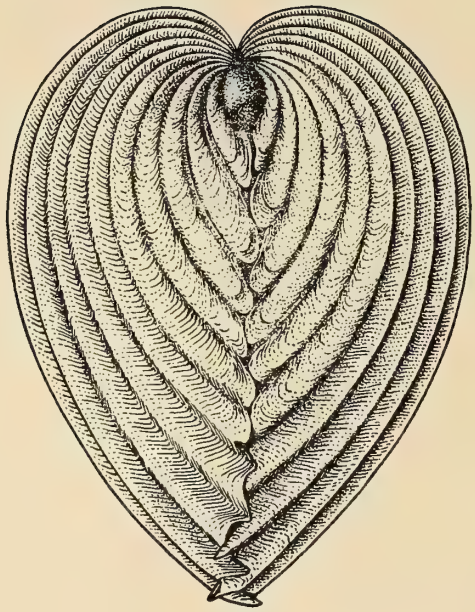

Note: The various taxa above species are indicated by the use of different type styles as shown by the following examples:

ORDER, Suborder, **DIVISION, Subdivision,** SECTION, SUPERFAMILY, FAMILY, Subfamily, *Genus*, (*Subgenus*).

Rediscovery of *Terebra formosa* Deshayes, 1857

BY

BRUCE CAMPBELL

Contribution from the "Sea of Cortez Marine Research Center", South Gate, California

(Plates 12, 13)

As a result of the recent paper, "Large Species of Terebra (Mollusca) from the Eastern Pacific" (Hanna & Hertlein, 1961), additional information has been brought to light regarding Terebra formosa Deshayes, 1857. The paper dealt with the five species of Panamic Terebra, in the strict sense, one of which was described as new, and offered appropriate synonymy in each case. Under the citations of T. lingualis Hinds, 1844, T. formosa was described from a single specimen with the locality of Panama, and since the original description it appears that no additional specimens have been reported. A single specimen in the collection of the Los Angeles County Museum, labeled T. formosa, was examined and found to be a fairly typical T. lingualis. A similar specimen in the Stanford University Collection, identified as T. formosa, also proved to be T. lingualis.

The original illustration of Terebra formosa reveals a shell with an acute apical angle and with the color pattern on the bodywhorl consisting of three rows of square chestnut spots. Due to the fact that the spotting is somewhat variable in this group and that slightly worn specimens of T. lingualis can be similar in characteristics with the original illustration of T. formosa, it was assigned to this species. What the illustration of T. formosa does show that is inconsistent with the morphe of T. lingualis is a wide subsutural collar that occupies more than half of each whorl on the anterior one-half of the shell.

I am indebted to Mr. Eugene Bergeron, director of Marine Biological Research Associates, Balboa, Canal Zone. Several months after publication of the Terebra paper (Hanna & Hertlein, 1961), five specimens of a Terebra were received by airmail from Mr. Bergeron (three specimens to the California Academy of Sciences and two to myself). They had been tentatively identified by Mr. Bergeron as T. formosa, and indeed this appeared to be correct as they matched both original figure and description exceptionally well. Three specimens that were collected at Mazatlán, Sinaloa, Mexico, in 1961 and labeled T. cf. formosa also proved to be typical T. formosa and extended the range 2,000 miles northwest.

My purpose is to retrieve from synonymy Terebra formosa Deshayes and restore it as a valid Eastern Pacific species of Terebra.

Specimens of Terebra available for study included those at the California Academy of Sciences; also made available to me were the specimens of Terebra in the collection at Stanforn University through the courtesy of Dr. Myra Keen, those in the collection of John and Rose Burch, and those in the Los Angeles County Museum through the courtesy of Mr. George Kanakoff.

Acknowledgement is made to Mr. Eugene Bergeron for his generosity in supplying material that is the basis of this paper, and appreciation is given Mr. R. D. Burch for the loan of four Terebra formosa and to Kenneth Boss for the negatives of the "Type" of T. formosa.

Family TEREBRIDAE H & A Adams
Genus Terebra Bruguière

Key to the species of Terebra
(Modified from Hanna & Hertlein)

1. A subsutural spiral groove present on all whorls 2
   A subsutural spiral groove present only on whorls on posterior half of shell . . 3
2. Color markings a series of conspicuous stripes; apical angle 18° . . T. strigata
   Color markings of four spiral rows of square spots on bodywhorl; apical angle 19° . . . . T. ornata

3. A subsutural collar less than half the width of whorl 4
   A subsutural collar greater than half the width of whorl; apical angle 15° . . . . *T. formosa*
4. Apical angle 18° to 21°; later whorls tumid . . . . *T. dumbauldi*
   Apical angle 8° to 12°; later whorls slender 5
5. Apical angle acute, 8° . . . . *T. lingualis*
   Apical angle broader, 12° . . . *T. robusta*

Terebra (*Terebra*) *formosa* Deshayes, 1857

(Pl. 12, Figs. 5, 8 to 13; Pl. 13, Figs. 3 to 6)

Original Description

Ter. testâ subulato-turritâ, solidâ, albâ, maculis quadratis rufo-castaneis biseriatim pictâ, quarum superioribus multo minoribus, anfractibus planulatis, indivisis, obliquè longitudinaliter corrugato-plicatis, plicis biseriatim granatis, anfractu ultimo et penultimo convexioribus, plicis evanidis; aperturâ subangustâ, columella crassâ, contorto-recurvâ.

English Translation

Shell subulately turreted, solid, white, painted with two rows of square reddish-chestnut spots, of which the upper ones are much the smaller, whorls flat, undivided, obliquely longitudinally wrinkle-plaited, plaits marked by two rows of grains, last and penultimate whorls more convex, the plaits faded away; aperture rather narrow, columella thick, twistedly recurved. (Reeve)

Type Specimen

Museum Cumingeanus, British Museum (Natural History). [Plate 13, Fig. 3] Length 71 mm., diameter of last whorl, 13 mm.

Type Locality & Range

"Hab. la mer de Panama."

The southern limit of the range appears to be Panama. Three specimens from Mazatlán, Sinaloa, Mexico, extend the range 2,000 miles northwest.

Explanation of Plate 12

Figure 1: *Terebra lingualis* Hinds. Hypotype 13[1]. Far Fan, Canal Zone; E. Bergeron, coll., July, 1961. Length 79 mm, body whorl diameter 16 mm. Figure 2: *Terebra ornata* Gray. Hypotype 4[1]. 5 miles south of Puerto Peñasco, Sonora, Mexico, dredged in 20 to 26 meters: B. Campbell, D. Shasky, A. Martin, September, 1959. Length 88 mm, b. whorl diameter 19 mm (The Veliger, 3 (4): 112, 1961). Figure 3: *Terebra robusta* Hinds. Hypotype 24[1]. Diving in 3 to 5 m near San Carlos Bay, Guaymas, Mexico. B. Campbell, coll., December, 1957. L. 88 mm, b. w. diam. 18 mm. Figure 4: *Terebra robusta*. Hypotype 14[2]. Venado Island, Republic of Panama, E. Bergeron, coll., 1960. L. 102 mm, body w. diameter 22 mm. Figure 5: *Terebra formosa* Deshayes. Hypotype 22[1]. Kobbe Beach, Canal Zone; E. Bergeron, coll., 1958. Length 108 mm, b. w. diameter 22 mm. Figure 6: *Terebra dumbauldi* Hanna & Hertlein. Hypotype 16[1]. Intertidally, Kobbe Beach; Bergeron, coll., October, 1961. L. 109 mm, b. w. diam. 31 mm. Figure 7: *Terebra strigata* Sowerby. Hypotype 15[1]. Far Fan; Bergeron, coll., July, 1961. L. 100 mm, b. w. diam. 29 mm. Figure 8: *Terebra formosa*. Hypotype 17[1]. Beach just south of Mazatlán, Sinaloa, Mexico. F. Chevalie, coll., November, 1961. L. 63 mm, b. w. diam. 14.5 mm. Figure 9: *Terebra formosa*. Hypotype 20[1]. Kobbe Beach; Bergeron, coll., 1958. L. 85 mm, b. w. diam. 16 mm. Figure 10: *Terebra formosa*. Hypotype 21[1]. Same data as for Figure 9. L. 92 mm, b. w. diameter 20 mm. Figure 11: *Terebra formosa*. Same specimen as in Figure 5. Figure 12: *Terebra formosa*. Hypotype 23[1]. Same data as for Figure 9. L. 104 mm, b. w. diam. 21 mm. Figure 13: *Terebra formosa*. Hypotype 229[3]. Littoral; the Causeway, Fort Amador, Canal Zone; W. B. Mackley, coll., 1962. L. 97 mm, b. w. diam. 17 mm.

[1] *ex* Bruce Campbell Collection; [2] *ex* Gale Sphon Collection; [3] *ex* R. D. Burch Collection.

Explanation of Plate 13

Figure 1: *Terebra lingualis* Hinds. Photograph of the Type in the British Museum (Natural History). *ex* Cuming Collection (Twila Bratcher, *photo.*) Figure 2: *Terebra robusta* Hinds. Photograph of the Type in the British Museum (Natural History) *ex* Cuming Collection (Twila Bratcher, *photo.*) Figure 3: *Terebra formosa* Deshayes. Photograph of the single Type located in the "Museum Cumingianus", British Museum (Natural History) (Kenneth Boss, *photo.*) Type locality: Panama. Length 71 mm, body whorl diameter 13 mm. Figure 4: *Terebra formosa*. Same shell as Figure 8 of Plate 12. Figure 5: *Terebra formosa*. Same shell as Figure 13 of Plate 12. Figure 6: *Terebra formosa*. Same shell as Figure 12 of Plate 12. (Figures 4, 5 and 6, Bruce Campbell, *photo.*)

1 2 3 4 5 6 7

8 9 10 11 12 13

Kodachromes by BRUCE CAMPBELL

Figure 1

Figure 2

Figure 3

Figure 4

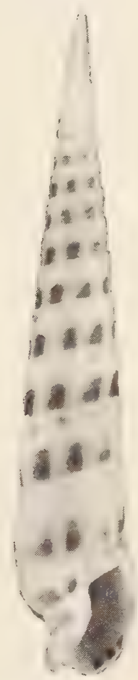

Figure 5

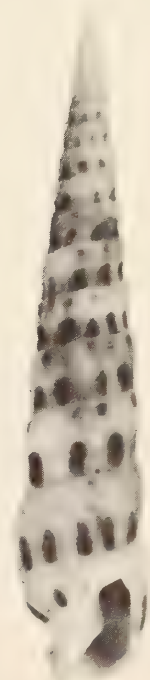

Figure 6

Specimens Examined

Three specimens CAS 37664 from Kobbe Beach, Canal Zone; Eugene Bergeron collector, 1958.

Five specimens (Campbell Collection) from Kobbe Beach, Canal Zone; Eugene Bergeron collector, 1958.

Three specimens (Campbell Collection) from the beach just south of Mazatlán Harbor, Sinaloa, Mexico; Sr. Francisco Chevalie collector, 1961.

One specimen (R. D. Burch Collection, no. 274) littoral; at Ferry, Fort Amador, Canal Zone; W. B. Mackley collector, May 1962.

One specimen (W. J. Eyerdam Collection); Panama Bay, Canal Zone.

One specimen (W. J. Eyerdam Collection); Corinto, Nicaragua; W. J. Eyerdam collector, May 11, 1939.

Discussion

Terebra formosa Deshayes was described from Panama on the basis of a single specimen of which Reeve remarks, "It is not in the best condition." Subsequent workers considered it possibly a young variety of either T. robusta (TRYON) or T. lingualis (REEVE), and it is true that all three species have three rows of spots on the bodywhorl and appear similar. Typically, the coloration of T. robusta consists of very irregular brown dots or blotches, roughly arranged in an axial manner, but there is considerable variation from specimen to specimen. Terebra lingualis displays flame-like reddish-brown axial stripes on some part of the shell and again variation is the rule. Terebra formosa seems to be more consistent. A row of small square chestnut spots that are smaller than the intervening area is present just anterior to the sutural groove; a row of larger square spots is present just posterior to this groove; and a third row is seen anteriorly on the bodywhorl. Although it is difficult to see any remarkable differences between T. robusta and T. lingualis in the early sculpture on the posterior half of the shells, the sculpture on T. formosa appears distinctly different. The subsutural nodes become oblique and narrower on an increasingly widening subsutural band. The axial ribs also take on this oblique nature. The most obvious difference, and probably the most reliable one, is the presence on the anterior half of the shell of a subsutural band more than one-half and up to three-fourths the width of the whorl. Both T. lingualis and T. robusta have bands considerably less than half the width which are separated from the remainder of the whorl by a small groove or line. The apical angle seems consistently different for each species and offers a simple method for separation. The narrow T. lingualis has an apical angle of approximately 8° rather than 12° as in T. robusta. Terebra formosa is more tumid with an apical angle of 15°; a small shell from Mazatlán matches Deshayes' original figure and the photograph of the "Type" very well.

I am not aware of any publication past or present where photographs of the "Types" of the large Eastern Pacific Terebra are available. Because of this, the validity of several species was open to speculation. In addition to the formosa-lingualis problem, some workers considered T. lingualis and T. robusta as conspecific. Photographs of the "Types" in the British Museum of T. lingualis Hinds, T. robusta Hinds, and T. formosa Deshayes (Plate 13, Figs. 1-3) are offered in hope that the confusion will be ended. The first seven figures of the color plate are typical representatives of the six species of Eastern Pacific Terebra s. s.; the remaining six figures are T. formosa Deshayes.

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A Poison-Secreting Nudibranch (Mollusca : Opisthobranchia)

BY

R. E. JOHANNES

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Thompson (1960) has reviewed defense mechanisms in opisthobranchs. He pointed out that while some secrete an acid when disturbed and others possess cnidosacs, many species possess neither weapon yet are seldom eaten by fish. The present report concerns a possible third defense mechanism. Tests with the nudibranch, Phyllidia varicosa Lamarck, 1801 (syn. P. trilineata Cuvier, 1804), indicate that when disturbed it secretes a profuse mucus containing a poison.

METHODS AND OBSERVATIONS

This study arose from the observation that a slipper lobster, Scyllarides squammosus (H. M. Edwards, 1837), and a homarid lobster, Enoplometopus occidentalis (Randall, 1839), died within an hour after a specimen of Phyllidia varicosa, dripping a light-grey mucus, was introduced into a 15-gallon aquarium with them. The work was performed using the mucus from four mature specimens of this nudibranch 9, 10, 12, and 13 cm. long. The mucus was collected in a beaker by gently squeezing the nudibranchs, an action which stimulated the flow of about five ml. of the mucus within a few seconds.

Three other species of crustaceans, Periclimenes spec., Lembos intermedius Schellenberg, 1938, and Tisbe reticulata Bocquet, 1951, and a poecilid fish, Mollinesia latipinna Le Sueur, 1821, invariably died within one-half to five hours after being placed in seawater containing approximately 2 percent of the mucus.

Lack of any response to being prodded with a dissecting needle was used as the criterion of death for all species. No animal ever recovered after being returned to fresh seawater at this stage.

Three or more individuals of each of the above species were also held under the same conditions minus the mucus. There were no deaths among these controls.

Table 1

Effect of Mucus of *Phyllidia varicosa* Lamarck, 1801 on Various Animals

Species	Approximate body length (mm)	Number tested	Number of controls	Death of all animals within ½ to 5 hours	No apparent effect after 24 hours
Lembos intermedius (amphipod)	3	numerous	numerous	+	
Tisbe reticulata (copepod)	1	numerous	numerous	+	
Periclimenes spec. (decapod)	30	numerous	numerous	+	
Mollinesia latipinna (teleost)	35	3	3	+	
Scyllarides squammosus (decapod)	150	2	0	+	
Enoplometopus occidentalis (decapod)	110	1	0	+	
Placobranchus ianthobapsus (nudibranch)	35	1	0		+
Metapograpsus messor (decapod)	25	1	0		+

Single specimens of a crab, Metapograpsus messor (Forskal, 1775) and a nudibranch, Placobranchus ianthobapsus Gould, 1852, showed no apparent ill effects after 48 hours' exposure to twice the concentration of mucus used on the other species.

The distress symptoms in the various susceptible species were varied and prevent much generalization. In mice and the walking crustaceans loss of control of the legs was one of the first symptoms noted.

A test with pHydrion pH paper showed the pH of the secretion to be approximately 7. The mucus had a strong, unusual smell. The descriptions of the smell given to the writer by several individuals were so varied and sometimes contradictory that no further description is attempted. The secretion had no apparent taste.

Groups of Periclimenes spec. and Lembos intermedius were used as bio-indicators in investigating the stability of the poison. Several of one or the other of these species were placed in 2 percent mucus-seawater which had been exposed to one of the treatments described below in order to determine if the poison had been inactivated. Either all the animals were dead within five hours or none died within ten hours. In the latter case the poison was considered inactivated. Control flasks were run in all cases.

In tightly stoppered flasks at room temperature the seawater-mucus mixture remained toxic for at least six days. However, the mixture lost its toxicity in less than three days in open flasks, suggesting that the poison is volatile. Subsequent tests supported this hypothesis. Mucus-containing seawater lost its toxicity within ten minutes when nitrogen, helium, or air was bubbled through it vigorously from an airstone.

In seawater the poison was not inactivated by exposure to temperatures as high as 95° C. for approximately one minute. The poison could be filtered out of seawater using an HA Millipore filter (0.45 μ pore diameter). The poison appeared to be trapped in rather than on the filter. Whole filters used to filter the mixture, then placed in flasks of seawater containing test animals, were not toxic. If the filters were finely shredded before they were introduced, they proved toxic.

Discussion

When disturbed, Phyllidia varicosa secretes in its mucus a substance which is toxic to a variety of animals. Apart from the problem of the chemical nature of this poison, an interesting question arises from this observation: is the poison of P. varicosa an isolated phenomenon among opisthobranchs or a third general defense mechanism? Certainly, some presently unexplained factor is operative in protecting the many soft-bodied opisthobranchs possessing neither cnidosacs nor acid secretions from predation.

Risbec (1928) states that a voluminous, strong-smelling mucus emitted by the animal when disturbed is characteristic of most Phyllidiads. If this strong smell is associated with the poison as it appears to be (whenever the poison was inactivated the smell disappeared), it would indicate that the poison is not restricted to Phyllidia varicosa but prevalent within the family Phyllidiadae.

With regard to opisthobranchs in general, Thompson (1960) points out the widespread occurrence of skin glands (apart from mucus and acid glands) "whose position and function can only be explained satisfactorily as defensive." The possibility that these glands secrete poisons and that poison secretion is not an unusual means of defense among opisthobranchs might be examined.

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Statistical Studies on Cowrie Radulae

BY

FRANZ ALFRED SCHILDER & MARIA SCHILDER

University of Halle (Saale), German Democratic Republic

(2 Textfigures)

In these last two years, Mr. R. S. Benton and Mr. W. O. Cernohorsky have sent us several thousand cowries from various localities of Kenya and Fiji, respectively. All these shells contained the complete animals, dried or still soft by being packed in cotton wool wet by spirits, so that we could ascertain the sex of each animal by presence or absence of a penis, and preserve the radula mostly in its entire length.

This rich material seems to be suitable to elucidate the correlation between the following characters:

- L The length of the shell, measured by a vernier caliper in tenths of a millimeter.
- ♀ Female sex of the animal.
- ♂ Male sex of the animal.
- r The number of rows composing the complete radula, the terminal "nascentes" included.
- m The maximum breadth of the median tooth of the radula, expressed in thousandths of a millimeter: the figures represent the mean of five medians measured in each specimen.
- dr The total length of the radula, expressed in tenths of a millimeter; it has been calculated by multiplying the number of rows (r) by the average distance (d) between the basal edges of two adjacent medians; d has been stated by measuring the length of the area occupied by 30 to 40 rows in various parts of the radula, in thousandths of a millimeter.

The mathematical significance of differences (Schilder, 1961b) has been marked as follows:

°	$P > 0.01$	No difference
*	$P < 0.01$	Difference certain
**	$P < 0.001$	Difference strictly proved

HISTORICAL REVIEW

In previous papers we have shown, though by far scantier material, the following relations among specimens of the same species:

1. The average L of ♂ is mostly smaller than that of ♀ (Schilder, 1962b).
2. r does not depend on L, whereas m and dr are correlated to L (Schilder, 1960).

Therefore, we have been enabled to establish the following indices:

r/12 = r:12 = number of rows, expressed in dozens (10 = 114 to 126 rows).
m/L = 2000 m:L = relative breadth of the median.
dr/L = 100 dr:6L = relative length of the radula.

The constants mentioned in these formulae have been chosen so that the average index of all cowries becomes 10 in every character; therefore, indices exceeding 10 indicate relatively numerous rows, broad medians, and long radulae, while indices smaller than 10 indicate less numerous rows, narrower medians, and shorter radulae than would be expected from the sum of all cowry species (Schilder, 1960).

We have shown that in Monetaria r/12 of ♀ is larger than that of ♂, while m/L of ♀ is smaller than that of ♂ (Schilder, 1961S), and dr/L is rather similar in both sexes (Schilder, 1962a): the females have more numerous rows than the males, but smaller teeth, so that the length of the radula ribbon becomes nearly equal.

The figures indicating the average indices are often quite similar in allied species, while they distinctly differ in species placed in different genera or even subfamilies conchologically (Schilder, 1941), so that they may confirm

or correct the taxonomy (Schilder, 1960, 1961c, 1962b).

RECENT RESEARCH

The present paper is an attempt to confirm or to emend these former results by extending the investigations to larger series of specimens of still more species.

The correlation between the length of the shell (L), and the number of rows of the radula (r), the breadth of its median (m), and the length of the ribbon (dr) may be shown once more by 66 male specimens of Lyncina lynx Linnaeus, 1758, collected by R. S. Benton within an area of about 63 meters at Shimoni on the southern border of Kenya, from March 1961 to April 1962. In Fig. 1, r indicates the number of rows, L and dr have been expressed in millimeters, m in hundredths of a millimeter; the results clearly are similar to those observed in Monetaria, mentioned above.

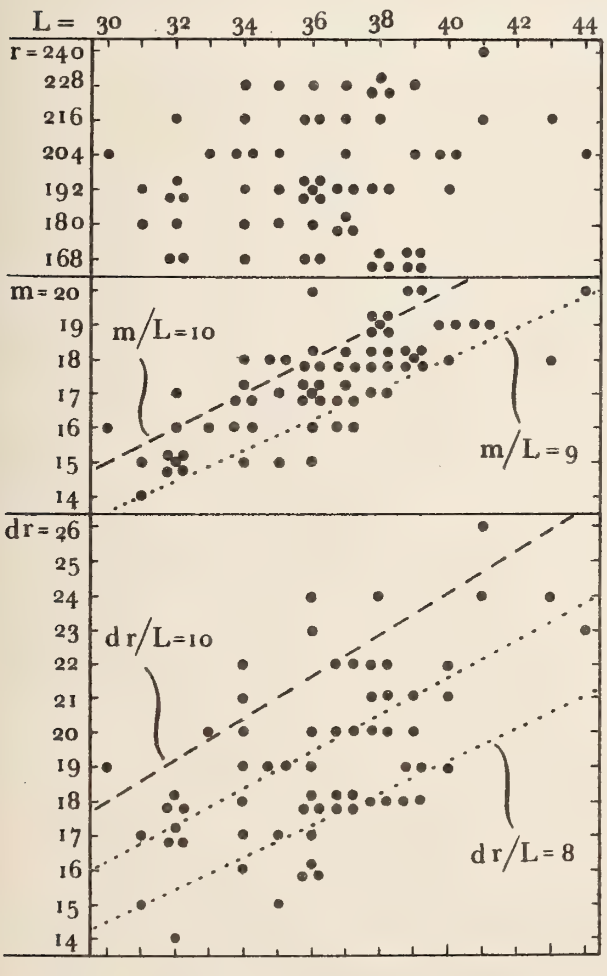

Figure 1: See Text for Explanation

The correlation between L and m may also be illustrated by Fig. 2, which shows the mean of 15 species examined in large numbers. The letters indicate the means of females, the arrow-heads those of males:

- a = Luria isabella Linnaeus, 1758
- b = Mauritia eglantina Duclos, 1833
- c = Lyncina lynx Linnaeus, 1758
- d = L. vitellus Linnaeus, 1758
- e = L. carneola Linnaeus, 1758
- f = L. titan spec. nov.
- g = Monetaria annulus Linnaeus, 1758
- h = M. moneta Linnaeus, 1758
- i = Erosaria helvola Linnaeus, 1758
- k = E. erosa Linnaeus, 1758
- l = E. lamarckii Gray, 1825
- m = Erronea errones Linnaeus, 1758
- n = E. caurica Linnaeus, 1758
- o = Palmadusta fimbriata Gmelin, 1791
- p = Bistolida teres Gmelin, 1791

These means are distinctly arranged along the line - - - - - - - indicating the index m/L = 10, but Luria isabella exhibits an exceptionally large median. The arrows seem to point in various directions, but they show that the shells (L) of males are smaller than or equal to those of females, but never larger, whereas the relative size of medians of males mostly exceeds those of females, though there may be sometimes no difference (as in Lyncina carneola) or even an exceeding of males by females (L. isabella, L. vitellus).

As all cowry species examined hitherto exhibit such a distinct correlation between L, m, and dr, but evidently the independence of r (Schilder, 1960; 1961a, c; and Fig. 1), the use of the indices explained above seems to be justified; therefore, we shall restrict our further research to these indices only.

The range of variation of the indices r/12, m/L, and dr/L may be illustrated by Table 1: it contains the variation of the specimens of each sex in several selected species. The significance of the differences between the means of ♀ and ♂ has been indicated by asterisks as explained above. The average deviation (Σ) of all species enumerated in Table 2 is in r/12 = 1.23, m/L = 1.29, dr/L = 1.45, varying from 0.8 to 2.7, 0.5 to 2.3, and 0.6 to 2.7, respectively.

Table 2 indicates the mean indices r/12, m/L, and dr/L in each sex of 15 frequent species (represented in Fig. 2). These indices, which have been reduced to one decimal, are preceded by the number of examined specimens (in parentheses). In each index, the columns

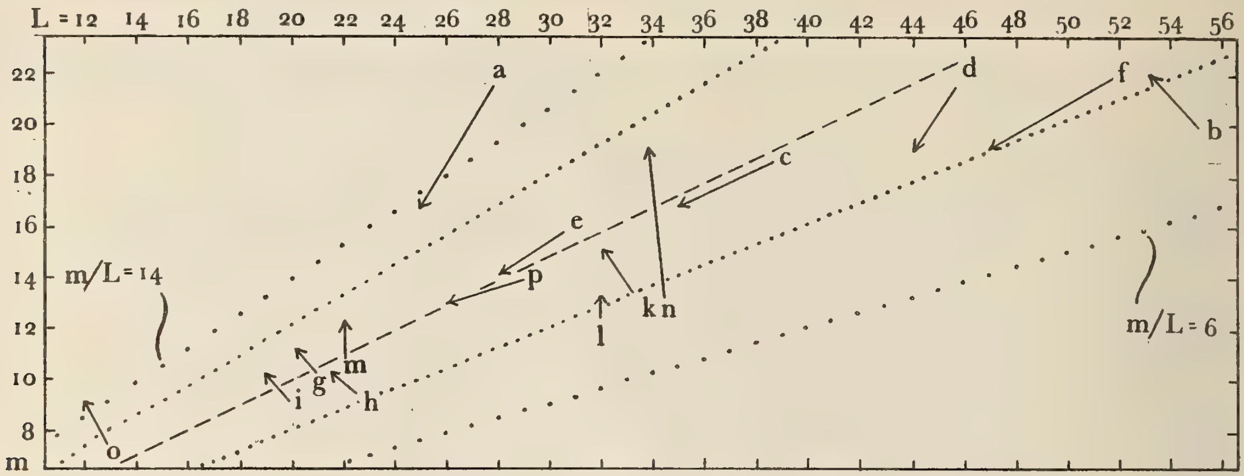

Figure 2: See Text for Explanation

Table 1

Range of Variation of Three Indices in Some Cowrie Species

Species	Sex	Index 4	5	6	7	8	9	10	11	12	13	14	15	Mean Difference
Number of Rows ($r/12$)														
Luria isabella	♀	—	—	—	—	4	7	13	16	11	5	1	2	10.88)**
	♂	—	—	—	3	13	10	21	8	9	1	1	2	9.97
Monetaria annulus	♀	—	—	—	1	2	6	21	20	22	5	2	—	10.94)**
	♂	—	—	—	—	6	25	13	4	3	—	—	—	9.47
Erosaria erosa	♀	—	—	—	—	6	13	22	17	5	2	—	—	10.12)**
	♂	—	—	—	—	9	21	25	10	—	—	—	—	9.55
Relative Breadth of Median (m/L)														
Mauritia eglantina	♀	—	—	7	27	12	3	—	—	—	—	—	—	7.22)**
	♂	1	2	2	9	16	12	4	—	—	—	—	—	7.93
Erronea caurica	♀	—	1	1	13	38	8	1	1	1	—	—	—	7.98)**
	♂	—	—	—	1	4	6	6	8	8	7	6	2	11.29
Lyncina carneola	♀	—	—	—	2	3	5	41	46	12	9	1	—	10.71)**
	♂	—	—	—	—	—	20	53	29	5	3	—	—	10.25
Lyncina titan	♀	—	—	—	2	29	23	7	—	—	—	—	—	8.57)**
	♂	—	—	—	11	42	13	4	—	—	—	—	—	8.14
Lyncina lynx	♀	—	—	—	—	1	33	43	18	5	—	—	—	9.93)°
(Kenya)	♂	—	—	—	—	—	39	37	17	3	—	—	—	9.83
id.	♀	—	—	—	—	7	13	6	—	—	—	—	—	8.96)°
(Fiji)	♂	—	—	—	—	2	14	3	—	—	—	—	—	9.06
Relative Length of the Radula (dr/L)														
Lyncina vitellus	♀	—	—	—	—	1	6	12	6	3	1	—	—	10.24)°
	♂	—	—	—	—	—	7	8	7	3	1	—	—	10.35
Erosaria helvola	♀	—	—	1	2	9	24	24	9	5	1	—	—	9.60)°
	♂	—	—	1	1	4	15	14	12	5	1	—	—	9.91
Erosaria lamarckii	♀	1	2	2	4	7	6	1	—	—	—	—	—	7.57)*
	♂	—	—	2	3	7	8	6	2	—	—	—	—	8.68
Erronea errones	♀	1	—	3	9	4	1	2	—	—	—	—	—	7.30)**
	♂	—	—	—	2	2	4	—	2	2	—	—	—	9.33

(see text for explanation)

for females and males are separated by the sign of the sex in which the index is larger and by the degree of significance of the difference between the sexes (see above). At the bottom, we have added three species, the numerous specimens of which came from two different regions: in each, the third line indicates the significance of local or racial differences in each sex (in each column the respective index is larger in the named region, with the indicated significance).

The East African and the Pacific specimens of Lyncina lynx and Monetaria moneta significantly differ in m/L and dr/L of both sexes, while r/12 is instead identical; in Erosaria erosa, however, such a significant difference exists in r/12 of males only. Besides, we see from Table 2 that in several species the sexes differ most significantly in all indices of the radula (Luria isabella, M. annulus, M. moneta, E. erosa, and Erronea caurica), while other species differ in one index or in the other, or even in none (L. lynx and Bistolida teres); the significance of sexual differences in the radula seems to be scattered as a specific character only, as hardly any relation to the affinity of species can be observed. On the other hand, the magnitude of the indices seems to be rather similar in many allied species, as well as the sex exhibiting the larger indices even if their differences cannot be proved as mathematically significant.

This fact may be reinforced by Table 3, which contains 50 species arranged according to Schilder (1941).

The three figures indicate the mean indices r/12, m/L, and dr/L, calculated from all examined specimens including those whose sex is unknown. The added signs ♀ or ♂ indicate the sex in which the index is larger, with **, *, or ° designating the degree of significance of the sexual difference. The absence of these signs points to a scarcity of specimens of known sex, which precludes stating them with satisfactory accuracy.

Table 2

Mean Indices for Both Sexes in Fifteen Species of Cowries

Species	Area	♀	r/12	♂	♀	m/L	♂	♀	dr/L	♂
Luria isabella	Indopacific	(59) 10.9	♀**	(68) 10.0	(62) 15.2	♀**	(71) 13.7	(59) 14.1	♀**	(68) 12.2
Mauritia eglantina	Fiji	(34) 13.0	♀**	(36) 11.4	(49) 7.2	♂**	(46) 7.9	(34) 10.2	♂°	(36) 10.4
Lyncina lynx	Indopacific	(119) 16.7	♀°	(105) 16.3	(126) 9.7	=°	(113) 9.7	(119) 9.2	♀°	(105) 9.0
Lyncina vitellus	Indopacific	(29) 17.8	♂°	(26) 19.0	(31) 9.7	♀*	(31) 9.0	(29) 10.2	♂°	(26) 10.3
Lyncina carneola	Kenya	(108) 17.8	♂°	(95) 18.0	(119) 10.7	♀**	(110) 10.3	(108) 12.3	♀°	(95) 11.9
Lyncina titan	Kenya	(46) 19.1	♂°	(58) 19.4	(61) 8.6	♀**	(70) 8.1	(46) 10.6	♀°	(58) 10.3
Monetaria annulus	Indopacific	(79) 10.9	♀**	(51) 9.5	(102) 9.7	♂**	(65) 11.4	(78) 9.2	♂**	(52) 10.2
Monetaria moneta	Indopacific	(191) 9.0	♀**	(107) 8.5	(244) 8.2	♂**	(164) 9.6	(191) 7.6	♂**	(107) 8.5
Erosaria helvola	Indopacific	(75) 9.4	♀**	(53) 8.7	(100) 9.3	♂**	(74) 10.2	(75) 9.6	♂°	(53) 9.9
Erosaria erosa	Indopacific	(65) 10.1	♀**	(65) 9.6	(81) 7.4	♂**	(81) 8.8	(65) 7.6	♂**	(65) 8.6
Erosaria lamarckii	Port Reitz	(23) 10.3	♂°	(28) 10.5	(29) 7.2	♂*	(40) 8.0	(23) 7.6	♂*	(28) 8.7
Erronea errones	Pacific	(20) 8.2	♀°	(12) 8.0	(37) 9.5	♂*	(24) 10.8	(20) 7.3	♂**	(12) 9.3
Erronea caurica	Kenya	(44) 9.0	♀**	(38) 8.3	(64) 8.0	♂**	(48) 11.3	(44) 6.8	♂**	(38) 8.8
Palmadusta fimbriata	Kenya	(17) 8.5	♀*	(14) 7.3	(28) 11.4	♂**	(16) 13.4	(17) 7.5	♂*	(14) 9.4
Bistolida teres	Indopacific	(13) 6.8	♂°	(10) 7.3	(18) 10.1	♀°	(18) 9.9	(13) 5.2	♂°	(10) 5.7
Lyncina lynx	Kenya	(94) 16.8	♀*	(89) 16.2	(100) 9.9	♀°	(96) 9.8	(94) 9.4	♀°	(89) 9.1
	Fiji	(25) 16.4	♂°	(16) 16.6	(26) 9.0	♂°	(17) 9.1	(25) 8.2	=°	(16) 8.2
	Kenya : Fiji	Kenya°		Fiji*	Kenya**		Kenya**	Kenya**		Kenya**
Monetaria moneta	Kenya	(158) 9.1	♀**	(86) 8.5	(197) 8.0	♂**	(129) 9.4	(158) 7.3	♂**	(86) 8.2
	Pacific	(33) 8.9	♀°	(21) 8.6	(47) 9.3	♂**	(35) 10.3	(33) 9.0	♂**	(21) 9.9
	Kenya : Pacific	Kenya°		Pacific°	Pacific**		Pacific*	Pacific**		Pacific**
Erosaria erosa	Kenya	(51) 10.1	♀**	(46) 9.3	(61) 7.5	♂**	(56) 9.0	(51) 7.7	♂**	(46) 8.7
	Pacific	(14) 10.4	♀°	(19) 10.1	(20) 7.1	♂**	(25) 8.5	(14) 7.4	♂*	(19) 8.5
	Kenya : Pacific	Pacific°		Pacific**	Kenya*		Kenya°	Kenya°		Kenya°

(see text for explanation)

Table 3

Three Indices for Fifty Species of Cowries

	r/12	*m/L*	*dr/L*		*r/12*	*m/L*	*dr/L*
Cypraeinae:				*Staphylaea staphylaea*	8 ♀*	12 ♂*	7 ♂°
Luria isabella	10 ♀**	14 ♀**	13 ♀**	*S. limacina*	7 ♀	15 ♂	8 ♂
L. tessellata	16	10	11	*Nuclearia nucleus*	10	8	7
Mauritia arabica	12 ♀	8 ♀	12 ♀	Cypraeovulinae:			
M. eglantina	12 ♀**	8 ♂**	10 ♂°	*Notocypraea piperita*	7	11	6
M. scurra	14	8	12	*N. bicolor*	6	10	5
M. histrio	11 ♀°	9 ♂°	10 ♂*	*Umbilia hesitata*	8	9	8
M. maculifera	14	8	13	*Erronea xanthodon*	9	10	10
M. mauritiana	16 ♀	7 ♀	10 ♀	*E. errones*	8 ♀°	10 ♂*	8 ♂**
Talparia talpa	16	7	5	*E. cylindrica*	8	10 ♂	8
Cypraea tigris	16 ♂°	8 =°	11 ♂°	*E. caurica*	9 ♀**	10 ♂**	8 ♂**
Lyncina lynx	17 ♀°	10 ♀°	9 ♀°	*E. felina*	9	8	7
L. vitellus	18 ♂°	9 ♀*	10 ♂°	*Palmadusta punctata*	7	10	8
L. carneola	18 ♂°	10 ♀**	12 ♀°	*P. clandestina*	9 ♂	10 ♀	5 ♀
L. titan	19 ♂°	8 ♀**	10 ♀°	*P. artuffeli*	8	11	4
Nariinae:				*P. lentiginosa*	9	9	6
Monetaria annulus	10 ♀**	11 ♂**	10 ♂**	*P. gracilis*	7 ♀°	11 ♂°	7 ♂**
M. moneta	9 ♀**	9 ♂**	8 ♂**	*P. japonica*	6	12	6
Erosaria boivinii	9	10	9	*P. fimbriata*	8 ♀*	12 ♂**	8 ♂*
E. helvola	9 ♀**	10 ♂**	10 ♂°	*Bistolida quadrimaculata*	9	8	6
E. caputserpentis	10	10	9	*B. teres*	7 ♂°	10 ♀°	5 ♂°
E. erosa	10 ♀**	8 ♂**	8 ♂**	*B. kieneri*	6 ♂	12 ♀	5 ♀
E. nebrites	10	8	9	*B. hirundo*	6	10	4
E. miliaris	11	8	8	*B. stolida*	7 ♀	10 ♂	4 ♀
E. eburnea	9	7	6	*Ovatipsa chinensis*	8	13 ♀	8
E. lamarckii	10 ♂°	8 ♂*	8 ♂*	*Cribraria cribraria*	14	6	7
E. turdus	10	9	9				

(see text for explanation)

Table 3 shows the following interesting facts which may be easily recognized by plotting the indices against the taxonomical arrangement of species:

r/12 ranges from 6 to 19: it is large (numerous rows) in A (maximum in Ae), medium in B (small in Bc only), and small in C (except in Cg); the means are 16, 10, and 8.

m/L ranges from 6 to 15: it is smaller (median tooth narrow) in A (but large in Aa) than in B (large in Bc) and in C (small in Cg); the means are 8, 9, and 10.

dr/L ranges from 4 to 13 (the radula is $\frac{1}{3}$ to $\frac{4}{5}$ as long as the shell, index = 8 indicates $\frac{1}{2}$ the shell): it is large (radula ribbon long) in A (except in Ac), medium in B, and small in C; the means are 11, 8, and 6.

Therefore, there is a gradual decrease in r/12 and dr/L from A (the primitive Cypraeinae) over B (Nariinae) to C (the highly developed Cypraeovulinae), so that the radula generally becomes shorter and composed of less numerous rows; on the other hand, the median seems to become gradually larger during the evolution of the family Cypraeidae. There is, however, a great overlapping in the species of these groups, and there are some genera aberrant in some respects, especially Aa, Ac, Bc (while Bd is typical Nariinae), and Cg.

The sexual differences in the indices are far less distinct, as in many groups there are species exhibiting an index larger in females, mixed with those exhibiting the same index smaller in this sex. Generally, the females surpass the males in r/12 only (in 68 percent of

r/12, the index in females is larger than in males), while in m/L (43 percent) and dr/L (36 percent) the females less frequently exceed. With regard to r/12, the females exceed chiefly in B and in A (except in Ad and Ae); but in no species of B do the females seem to exceed in m/L nor in dr/L.

Summary

The indices r/12, m/L, and dr/L, indicating the number of rows of the radula, the size of its median, and the length of the radula ribbon (the last two characters related to the length of the shell), seem to represent an accessory argument for the taxonomical arrangement of cowry species and genera.

Acknowledgment

We are very much indebted to Mr. Ronald S. Benton, formerly at Mombasa, Kenya, and to Mr. Walter O. Cernohorsky, at Vatukoula, Fiji, for their admirably unselfish support of our studies by indefatigably collecting large series of cowries at restricted localities, and by preserving them so that the animals can be well examined after being in transit for eight to ten weeks to Germany. Mrs. Edith Kilian, Zoological Institute of the University of Halle, Germany, has carefully prepared several thousand radulae for microscopical research.

ADDITIONAL NOTE

In the present paper we have included also Lyncina titan which we are about to establish in another paper (Archiv für Molluskenkunde, Vol. 91, pp. 4-6, December 1962). Lyncina titan differs from L. carneola (Linnaeus, 1758) chiefly by its enormous size, which is about twice as large and leaves a distinct gap in range of variation between the two sibling species; the limit in size slightly differs in sexes and in populations, but it is always striking. There are also accessory differences, especially in the radula: in L. titan r/12 is larger, but m/L and dr/L are smaller than in L. carneola; all differences are significant in both sexes. We must call L. titan a distinct species, as it lives in some places of East Africa (but not in all places!) together with L. carneola without breeding indeterminable intermediates: it looks like a polyploid species. The East African L. titan must not be confounded with the Polynesian L. leviathan Schilder & Schilder, 1937. The holotype of L. titan has been collected by R. S. Benton in Shimoni (East) at the Southern border of Kenya, 28 August 1961 (coll. Schilder 13208): its formula is 67(57)32: 27.

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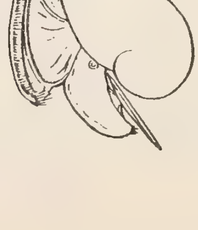

The California Land Snails *Helminthoglypta reediana* Willett and *Helminthoglypta similans* Hanna & Smith with Comments on their Relationships (Gastropoda : Pulmonata)

BY

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The suggestion has been made by Pilsbry and others that Helminthoglypta reediana Willett, 1932, and H. similans Hanna & Smith, 1937, may be conspecific. There are good reasons for this supposition; first, because of the similarity in the descriptions of the shells, and second, because the range of H. similans may overlap the area of the type locality of H. reediana.

In order to provide some information on this problem the paratypes of Helminthoglypta reediana were borrowed for study several years ago from the Los Angeles County Museum through the courtesy of the late George Willett for the purpose of making a comparison with paratypes of H. similans in the collection of the California Academy of Sciences. Unfortunately, it was not possible to compare the holotypes of the two species, but some basis for such a comparison is found in the published figures. The inability to compare them directly is not a serious lack, however, as the holotype of H. similans is a representative specimen, the characters of which are found also in the paratypes. It is assumed that the same is true for the paratypes of H. reediana; at least the description agrees generally with the characters exhibited by the more adult shells in the paratype lot.

The paratypes of Helminthoglypta reediana, eight in number, are all good though immature specimens that show significant sculptural characters plainly. The three largest are apparently close to maturity though they lack the reflected and slightly thickened peristome of adult shells. The nuclear whorls of H. reediana and of H. similans have about the same type of sculpture. In this respect both species are like H. carpenteri (Newcomb, 1861), which is found in the same general area. The early postnuclear whorls of all three species also are not greatly different. In H. reediana and H. similans they show anastomosing lines of growth that give the surface of the shells a dull matte appearance; and both species have round or elongate papillations, not particularly closely set but arranged in a descendingly spiral direction. Better preserved shells of both species exhibit areas of microscopic, wavy-lined sculpture visible only under a magnification of about 40 X. However, in H. reediana the papillations are generally more pronounced than in H. similans, but this difference, in itself alone, is hardly enough reason to separate the two species subspecifically, and certainly not enough for specific separation.

The most striking difference between the two species occurs in the sculpture and general texture of the bodywhorl. The three largest paratypes of Helminthoglypta reediana show a most unusual sudden change in the sculptural characters of the bodywhorl from those that precede it. On each of these three shells, after the final resting (estivating) stage before the snail becomes adult, the newly formed whorl is smooth and shiny, especially on the base. The papillations disappear, and their place is taken by incised spiral lines. Lines of growth no longer coalesce in an irregular manner but become generally continuous over the entire whorl. On these three shells this change takes

place at $4\frac{7}{8}$, $5\frac{1}{4}$, and $5\frac{1}{2}$ whorls, respectively; the other five paratypes are apparently too immature to show this change. It is not possible to say whether this sudden sculptural change is true also on the holotype either from the description or the published figure, but it should be easy to determine from a close examination of the holotype itself.

In general shape *Helminthoglypta reediana* and *H. similans* are close, as Willett has pointed out. The incised spirals on the bodywhorl of *H. reediana* in the adult stage are not as strongly marked as in most good specimens of *H. carpenteri*, although some lots of the latter species in the collection of the California Academy of Sciences from the northern end of its range show a weakening of these lines. Spiral markings on *H. similans*, if present at all, are still less of a sculptural feature. There is, however, one sure method of determining the relationship of *H. reediana* to the other two species. If the mantle of the living animal is of a uniformly gray or brownish-gray color without other markings, its relationship is close to *H. carpenteri*; but if the mantle is densely blotched with black, it is closer to *H. similans*. Unfortunately, none of the paratypes of *H. reediana* affords a clue to this relationship. To determine the point new material must be collected alive, which need not be adult.

The differences between *Helminthoglypta reediana* and *H. similans*, as indicated by slightly larger size, a somewhat wider umbilicus, and the greater number of whorls of the former, together with the sculptural differences in the bodywhorl of the two species, seem sufficient to warrant leaving them as separate species. No advantage can be seen to accrue by merging them without more and better evidence based upon additional specimens of *H. reediana* from the type locality in Lowe Canyon, southern Monterey County, which "lies between Ranchita and Vineyard Canyon road, which runs from San Miguel to Parkfield". Until such evidence is at hand, the true relationships to other species must remain open to a certain amount of speculation.

As *Helminthoglypta reediana* is reported to have been collected in the "vicinity of Paso Robles", which is in the northern end of San Luis Obispo County, it seems pertinent to comment on a set of dead and broken "bones", including seven fairly good immature shells collected in this area and now in the writer's collection (AGS No. 5509). This lot is a curious assemblage of papillated and striated shells, all of the best juveniles being papillate although one of these shows the peculiar break in sculpture found in *H. reediana*. Some of the adult shells are definitely not this species, however, and seem closer to *H. carpenteri*, although one or two of the better immature specimens show evidence that the snail had the black-maculated mantle of *H. similans*. In general, the shells are of the size of *H. similans* but are noticeably more globose with a small umbilicus, as in both this species and *H. carpenteri*. This lot was collected by E. E. Hand in 1931 in the "second canyon back of Thompson's Auto Camp, Paso Robles, California". Collecting in this area is difficult, as snails are hard to find, especially living adults in good condition. The probabilities are that one would most likely find them under live-oak deadfalls or similar cover in the hills to the west of the Salinas River.

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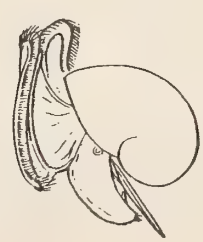

Notes on the Opisthobranchs of the West Coast of North America

II. The Order Cephalaspidea from San Diego to Vancouver Island

BY

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In attempting to prepare a key to the species of the Order Cephalaspidea recorded from San Diego, California, to Vancouver Island, British Columbia, I have become increasingly aware that a key to these species, as they are now known, is not feasible at this time. However, it is possible to present a statement concerning the systematic problems existing in the Order Cephalaspidea, as it is known on this coast. I hope that such a statement, together with a species list, will stimulate the additional research necessary to resolve some, if not all, of these problems.

Although a number of cephalaspideans have been described from the area under consideration, virtually nothing is known of the anatomy of the animals. Many species are quite small and have been obtained alive only by dredging. The systematic arrangement which is presently in use by conchologists on the west coast is artificial in that it depends too heavily upon shell characters (e. g., see: Keen & Pearson, 1952; Burch, 1945a, 1945b; Keen, 1958). The shells of some species offer so few characters for positive identification that, without knowledge of the external and internal anatomy of the animals themselves, it is impossible to establish their systematic position at the familial or the subordinal level. Pilsbry (1895, 1896) was aware of this problem, and his keys to the families of the order, based upon the characteristics of the radula and the development of the parapodia, was a major step toward providing some rational system of classification for this group. Since then, the cephalaspideans have received much attention in Europe where they are well known (e. g., see: Pruvot-Fol, 1954).

Without knowledge of the soft parts of the animals, it is impossible to relate the systematic position of most of our cephalaspideans to those in other parts of the world. For that matter, until more information is obtained, the relationships between the species already described will be doubtful. Burch (1945a, 1945b) gives a good account of the problems involved in working with west coast species, and, although Oldroyd (1927) may be outdated for other groups of mollusks, her account of the cephalaspideans is still useful. Keen & Pearson's key (1952) is excellent for determining the generic position of the shells of this group as they are now known, and, as many species range from Southern California southward, Keen's later treatment of the group for tropical west America (1958) is also helpful.

The Order Cephalaspidea is divided into three suborders. The shell is external in the Suborders Bullacea and Scaphandracea; however, parapodia (upwardly directed lateral extensions of the foot) are present in the Suborder Scaphandracea but absent in the Suborder Bullacea. The shell is internal in the Suborder Philinacea. It is in the Suborders Bullacea and Scaphandracea that most of the systematic problems exist. For the placement of the families and genera discussed below, the reader is referred to the list of species at the end of this paper.

The Genus Microglyphis Dall, 1902, is usually placed in the Family Acteonidae (Suborder Bullacea). Acteonids possess an operculum, but Dall in his original description states that Microglyphis is inoperculate. The shells of Mi-

croglyphis are markedly similar to those of members of the Family Ringiculidae, a family which is closely allied to the Family Acteonidae. I have tentatively placed this genus in the Family Ringiculidae in the list at the end of the paper.

The Family Acteocinidae has been used, in the area under consideration, as a catch-all for species whose shells bear some resemblance to one another. It is usually composed of the following genera: Acteocina Gray, 1827; Coleophysis Fischer, 1883; Retusa Brown, 1827; Volvulella Newton, 1891; and Sulcoretusa Burch, 1945. Keen (1958) also includes Cylichna Lovén, 1846, and Cylichnella Gabb, 1873. However, when the entire organism is considered, Acteocina, Cylichna, and Cylichnella are genera usually assigned to the Family Scaphandridae, and a species of Retusa, R. truncululata (Bruguière, 1772), is the type of the Family Retusidae, the Family Scaphandridae being included in the Suborder Scaphandracea and the Family Retusidae in the Suborder Bullacea. Pruvot-Fol (1954) synonymizes Volvulella with Volvula A. Adams, 1850, and includes the latter genus in the Family Bullidae (Suborder Bullacea). Although the concept of what actually constitutes the Family Acteocinidae on our coast appears to be somewhat obscure, I have retained the family in the list, including in it, however, only the species assigned to Acteocina by previous workers and the following species of "Retusa".

Sulcoretusa is a name proposed for the preoccupied Sulcularia Dall, 1921, which was originally used as a "section" of the genus Retusa but was subsequently raised to generic rank (see Burch, 1945a). Two species, Retusa xystrum Dall, 1919, and R. (Sulcularia) montereyensis Smith & Gordon, 1948, must be considered here. If they are correctly placed in the Family Acteocinidae, then a change must be made in their generic placement. I have retained both species in the Family Acteocinidae in the list only for convenience, as I have no evidence to suggest that they would be better placed elsewhere at this time. It may be that the genus Retusa (Suborder Bullacea) is not represented on our coast by any of the presently known species of cephalaspideans.

Coleophysis was also used by Dall as a "section" of Retusa for R. harpa Dall, 1871, but Burch (1945a) gives it full generic standing and includes Acteocina carinata Carpenter, 1857, in this genus. I have retained A. carinata in the genus Acteocina in the list.

According to Jefferson Gonor (University of Washington; written communication, June 1961), Retusa harpa belongs to the Suborder Scaphandracea and appears to be similar to species in the genus Acteocina. I have retained this species in the Family Acteocinidae as "Retusa" harpa. Further work needs to be done before this species may be assigned to a genus in the Suborder Scaphandracea.

The genus Cylichna is correctly included by Burch (1945a) in the Family Scaphandridae, and he considers the Californian species of Cylichnella to be more correctly placed in Cylichna. I have placed all of the species of Cylichnella in Cylichna on Burch's authority. Gonor (written communication, June 1961) suggests that the two are probably synonyms. However, Burch (loc. cit.) also lists Diaphana Brown, 1827, in the Family Scaphandridae. A species of Diaphana, D. minuta Brown, 1827, is the type upon which the Family Diaphanidae is based. This family belongs to the Suborder Bullacea.

I have included Broctonia Iredale, 1915, represented in California by B. polystrigma (Dall, 1908), in the Family Scaphandridae only because Dall, in his original description, states that the shell resembles Cylichna. It may, however, belong to an entirely different family or even a different suborder.

The names Acteocina and Volvulella have been rejected by Marcus (1955) and Pruvot-Fol (1954), respectively, as being invalid for Recent genera because they have fossil forms as type species. Marcus gives an excellent discussion of the reasons for using the name Tornatina A. Adams, 1859, in preference to Acteocina. I agree with Marcus that it is not advisable to base a Recent genus upon a fossil form in cases where the anatomy of the animal is the primary means of identification; however, in order not to confuse the literature with name changes which may subsequently prove to be incorrect, I have retained the names Acteocina and Volvulella in the list.

Haminoea Turton & Kingston, 1830, is erroneously placed by our conchologists in the Family Akeridae (also spelled Aceridae). It actually belongs to the Family Atyidae. This family is included in the Suborder Scaphandracea.

Keen & Pearson (1952) place our Atys in the Family Scaphandridae so there may be some doubt as to which family our species of Atys may belong. I have included them in the Family

Atyidae.

Because of the confusion which exists in determining the exact placement of many members of the Suborders Scaphandracea and Bullacea and because the relationships between most of the species known on our coast have not been worked out satisfactorily, I have not attempted a thorough investigation of the individual species listed below. Until our species are more fully known, such an investigation would be both time consuming and relatively futile. The works which have been cited above, including those containing original descriptions of species, are included in the bibliography. In addition, the reader is referred to the works of Dall (1921) and Grant & Gale (1931).

Acknowledgment

I am deeply grateful to Mr. Jefferson Gonor, Department of Zoology, University of Washington, for reading the manuscript and for his helpful criticism. I would also like to thank Dr. Leo Hertlein and Mr. Allyn G. Smith of the California Academy of Sciences for their comments.

List of Species in the Order CEPHALASPIDEA
(San Diego to Vancouver Island)

CEPHALASPIDEA

Bullacea

ACTEONIDAE

Acteon painei DALL, 1903
Acteon punctocaelatus (CARPENTER, 1864)
Acteon traski STEARNS, 1898

RINGICULIDAE

Microglyphis breviculus DALL, 1902
Microglyphis estuarinus DALL, 1908

BULLIDAE

Bulla gouldiana (PILSBRY, 1893)
Bulla quoyana (DALL, 1919)
Volvulella californica DALL, 1919
Volvulella cooperi DALL, 1919
Volvulella cylindrica (CARPENTER, 1863)
Volvulella tenuissima WILLETT, 1944

RETUSIDAE

No known species within the range under consideration are definitely assignable to this family.

DIAPHANIDAE

Diaphana californica DALL, 1919

Scaphandracea

SCAPHANDRIDAE

Broctonia polystrigma (DALL, 1908)
Cylichna alba (BROWN, 1827)
Cylichna attonsa (CARPENTER, 1865)
Cylichna diegensis (DALL, 1919)

ACTEOCINIDAE

Acteocina carinata CARPENTER, 1857
Acteocina culcitella (GOULD, 1852)
Acteocina eximia (BAIRD, 1863)
Acteocina inculta (GOULD, 1856)
Acteocina infrequens (C. B. ADAMS, 1852)
Acteocina intermedia WILLETT, 1928
Acteocina magdalenensis DALL, 1919
Acteocina oldroydi DALL, 1925
Acteocina planata DALL, 1919
Acteocina smirna DALL, 1919
"Retusa" harpa DALL, 1871
"Retusa" montereyensis SMITH & GORDON, 1948
"Retusa" xystrum DALL, 1919

ATYIDAE

Atys casta CARPENTER, 1864
Atys nonscripta (A. ADAMS, 1850)
Haminoea olgae DALL, 1919
Haminoea vesicula GOULD, 1855
Haminoea virescens (SOWERBY, 1833)

Philinacea

PHILINIDAE

Philine alba MATTOX, 1958
Philine bakeri DALL, 1919
Philine californica WILLETT, 1944
Philine polaris AURIVILLIUS, 1885

GASTROPTERIDAE

Gastropteron cinereum DALL, 1925
Gastropteron pacificum BERGH, 1893

AGLAJIDAE

Aglaja adellae DALL, 1894
Aglaja diomedea (BERGH, 1894)
Aglaja nana STEINBERG & JONES, 1960
Aglaja ocelligera (BERGH, 1894)
Aglaja purpurea (BERGH, 1894)
Chelidonura phocae MARCUS, 1961
Navanax inermis (COOPER, 1862)

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Studies on Mollusk Populations
V. -- *Tegula rugosa* (A. Adams, 1853)

BY

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(4 Textfigures)

Arthur Adams described Chlorostoma rugosum at the meeting of the Zoological Society of London under the date of May 27, 1851 (actually published in 1853) as follows:

"*C. testâ turbinatâ, profundè umbilicatâ, luteo-fuscâ, nigro variegatâ, longitudinaliter nodoso-plicatâ, transversim sulcatâ; anfractu ultimo rotundato, infra suturam angustato; columellâ incurvatâ, anticè bituberculatâ, tuberculo supremo magno, prominente; labro fusco marginato.*
Hab. —?"

This brief description may be translated, somewhat freely, as follows:

'The shell of this Chlorostoma is top shaped, deeply umbilicate, yellowish brown with black markings, longitudinally with nodose folds and transversely with grooves; last whorl rounded, narrowed at the suture; columella incurved with two tubercles anteriorly, the upper of which is large and prominent; lip with brown margin.

'Habitat unknown.'

Fischer (1880) redescribed this same species in the large Iconograph of Kiener as Trochus rugosus, A. Adams:

"*Trochus rugosus*, A. Adams. *Testa anguste perforata, conoidea, crassa, rudis; anfractus 5-6, superne et plerumque erosi, oblique striati, sordide fusco-cinerei, fulvo obscure et radiatim flammulati, convexiusculi; ultimus tumidus, ad suturam late appressus, marginatus et irregulariter lamelloso-plicatus; spiraliter cingulatus, interdum radiatim subplicatus, infra convexus et concentrice, sulcis 6-7, apertura rhomboidea, nigro vel purpureo marginata; columella brevi, bidentata, dente superno majore; callo umbilicari perforationem partim tegente.*"

This somewhat difficult description, in which important words seem to be missing, was accompanied by a more complete and comprehensive French description.

Fischer (l. c., p. 232) compares this species with "Trochus euryomphalus Jonas" which, he states, is 'equally perforate but differs by its coloration, its smaller shell, its spiral grooves etc.' (translation mine).

Pilsbry (1889) in Tryon's Manual describes the same species, again as Chlorostoma rugosum:

" Shell narrowly umbilicate, conoidal, solid, heavy, dull cinereous, more or less variegated by brown, blackish or red streaks; spire conoidal, generally eroded and white or yellow at the apex; whorls, about 5, obliquely striate, radiately coarsely and irregularly plicate and rugose above, sometimes nearly smooth; periphery rounded; base convex, concentrically lirate; aperture oblique; columella strongly dentate in the middle or below it, with a second small tooth at the base; edge of the columella rather deeply curved above the tooth, but spreading at its junction with the whorl, bounding and somewhat narrowing the umbilicus by a white callus, which does not extend to the upper margin of the aperture; umbilicus deep, white within. Alt. 26, diam. 27 mm."

In the discussion of the species, following this more thorough description, Pilsbry adds: "A rude, rugose species, like C. aureotinctum; but much less coarsely sculptured, with narrower umbilicus . . . . "

Keen (1958, p. 259) states: "Tegula (Omphalius) rugosa (A. Adams, 1853) . . . . The rough turban shell is heavy and dull gray, variegated with brown, black, or red streaks; the whorls are roughly and irregularly sculptured with oblique folds and some spiral threads. The umbilicus is deep and white within. . . . "

In the collection of the Department of Zoology, University of California, Berkeley, there are eleven lots of Tegula rugosa from various collecting stations on the west shore of the Gulf of California. It was possible for me to collect two fairly large random samples of populations about thirty miles south of the town of San Felipe, Baja California, Mexico. These samples are from two different areas, perhaps less than 500 meters distant from each other, but separated by a sandy beach devoid of any rocks or other solid objects to which a Tegula might cling. The other lots in the collection of the Department have been received from various sources and do not represent truly randomly collected specimens, as none of these lots include juvenile specimens.

In comparing our specimens with the various descriptions, several discrepancies were noted. The umbilicus showed great variability, and similarly, the sculpturing of the shell did not agree closely with the descriptions. While it must be admitted that the definition of colors of a shell will always remain a more or less subjective undertaking, nevertheless, to my eyes the shells of Tegula rugosa appear green rather than gray or ashy. Because of these differences, rather striking to me, a careful examination was made of all 290 shells and the results were recorded. After the addition of two more lots early in 1962, the new total of 304 shells was again examined and the results were again recorded. It is sufficient to state that for two shell characters (umbilicus and ornamentation) the two sets of results were identical (except for the additional specimens); the appraisal of the color varied, but only very slightly.

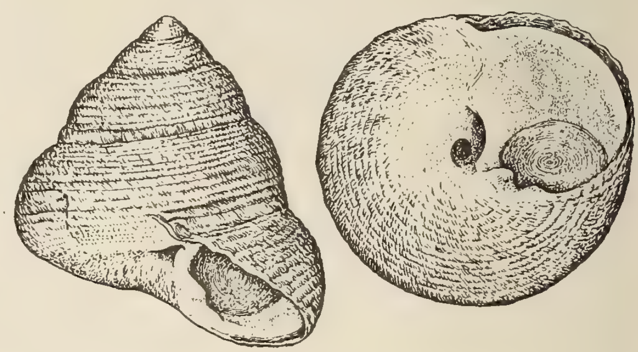

Figure 1: *Tegula (Omphalius) rugosa* (A. Adams, 1853)
Lateral and ventral aspects of an unusually well preserved specimen.
Puertecitos Cove, Baja California, Mexico.
ex coll. Dr. Donald R. Shasky. x 1.6

Umbilicus: Figure 1 shows an exceptionally fine specimen of the species under discussion, from the collection of Dr. Donald R. Shasky; it is not included in our study but was used as it illustrates the various shell characters rather well. Among these, however, the umbilicus exhibits one of the extreme conditions observed — it is not only deep as stated in the original description by Adams (l. c.) but it is extremely wide open. Figure 2b illustrates the form of the umbilicus encountered in the majority of our shells (i. e. 50.33 %); here the umbilicus is deep, indeed, but the columella forms what I call a 'fold', narrowing the umbilicus. Figure 2d represents perhaps a transition to the imperforate

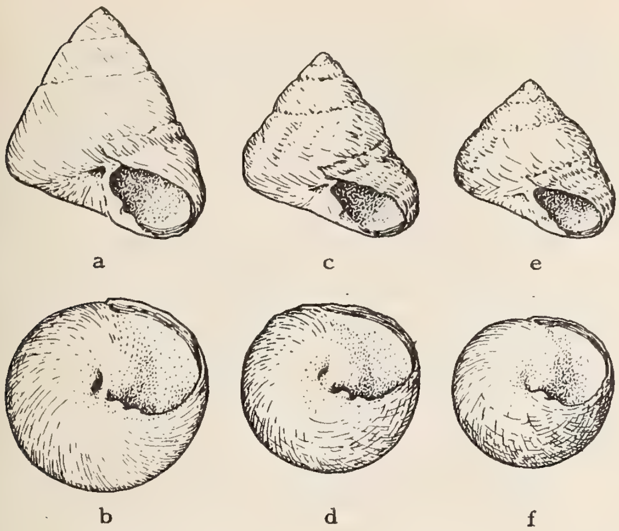

Figure 2: *Tegula (Omphalius) rugosa* (A. ADAMS, 1853)

Lateral and ventral aspects of specimens collected January 24, 1959, on rocks approximately 30 miles south of San Felipe, Baja California, Mexico.

Figure 2 a: unusually high form; figure 2 e: shape most commonly encounterd; figure 2 b: umbilicus narrowed by columellar callus; figure 2 d: umbilicus reduced to a "pit"; figure 2 f: umbilicus absent.

ex coll. Department of Zoology, University of California, Berkeley. x 1.0

condition, as here the callus formed by the columella narrows the umbilicus to what may be termed a mere pit, of variable depth, but never as deep as the two first mentioned conditions. Finally, the umbilical area may be closed, represented by a more or less shallow depression — or it may be completely flat and smooth.

In Table 1 are reproduced the results of my counts of the various lots, the latter arranged chronologically. Above the designations chosen for the various conditions of the umbilical area are small sketches showing the criteria used in segregating the individual specimens. It may be noted that 19.08 % are widely and deeply umbilicate, 50.33 % are narrowly and deeply umbilicate, 12.83 % are extremely narrowly and rather shallowly umbilicate, while a total of 17.76 % are imperforate; these latter shells may be separated into two groups (as stated above): one with a shallow depression, comprising 9.21 % of the grand total, the other completely imperforate, with 8.55 % of the grand total. Somewhat differently expressed, the shells in this study agree, as far as the perforation is concerned, only up to 70 % with the generally unanimous statement by the cited authors: "deeply umbilicate"; only slightly more than 62 % agree with Pilsbry's description: "narrowly umbilicate". If all the shells that show any sort of perforation are counted together, we find approximately 82 % in this category. In my opinion, however, the umbilicus which I designated as 'pit' does not agree with what the different authors described, and

Table 1

Frequencies in Differences in the Umbilical Area of *Tegula (Omphalius) rugosa* (A. ADAMS, 1853) in the Collection of the Department of Zoology, University of California, Berkeley

Locality	Date[2]	Collector	 wide open	 fold	 pit	 depression	 imperforate
San Felipe	II 1929	H. N. Lowe		2			1
Los Angeles Bay	23 X 1957	North & Scotten	1 (1)				
San Felipe	28 XI 1957	M. Turver	3 (3)	6 (1)	2 (1)	1	
30 mi S San Felipe[1]	24 I 1959	R. Stohler	31 (4)	128 (7)	20 (1)	13 (1)	8
60 mi S San Felipe[1]	I 1959	P. Fleischer	4				
30 mi S San Felipe[1]	20 II 1959	R. Stohler	9 (1)	5	11 (1)	10	15
N edge of San Felipe	21 II 1959	F. Wolfson				1	
36 mi S San Felipe[1]	22 II 1959	R. Stohler		1 (1)			
San Luis Gonzaga	27 III 1961	F. Wolfson	5 (1)	7 (4)	2	2	2
15 mi S San Felipe[1]	24 XII 1961	F. Wolfson		2	2		
Puertecitos	31 III 1962	F. Wolfson	5	2	2	1	
		Totals:	58 (10)	153 (13)	39 (3)	28 (1)	26

[1] approximate number of miles south of the town [2] months in roman numerals

The numbers in parentheses refer to individuals showing a wavy sculpture on the whorls

Table 2

Measurements (in millimeters) of the Largest and Smallest Specimens in a Random Population of *Tegula (Omphalius) rugosa* (A. ADAMS, 1853) from approximately 30 miles South of San Felipe

	Largest		Smallest	
	Height	Width	Height	Width
Umbilicus wide open	32.5	31.8	11.3	13.4
With fold	32.4	27.8	10.6	13.0
Pit	29.0	27.3	9.6	11.4
Depression	28.2	26.8	7.9	10.8
Imperforate	22.9	25.8	9.7	11.8

we would therefore have about 30% of the shells not covered by these descriptions.

It might be assumed that the condition of the umbilicus, i. e. whether it is wide open or completely imperforate, is correlated with the age of the animal. However, the figures in the accompanying Table 2 show clearly that this would be erroneous. In the sample of 200 specimens which I collected in January 1959 there were 28 measuring less than 20 millimeters in maximum height, and of these there were 7 measuring less than 14 millimeters. A shell of over 16 or 18 millimeters has the appearance of a "mature" shell, losing the juvenile character of being wider than high. This is not to say that among truly adult shells none will be found which are wider than high. Rather, all juvenile shells are much more obese, having an obesity index exceeding 100. As will be noted from Table 2, truly juvenile shells are represented in all five classes of umbilical condition, just as are adult shells.

Sculpture: Even more divergence is noted in regard to the character described by Pilsbry (l. c., p. 173, line 7) "radiately plicate and rugose above . . . ." This condition, illustrated in Figure 3, is observed in but 8.88% of our specimens (see Table 1, figures in parentheses). Particularly startling to me was the statement by Pilsbry (l. c.) in the discussion of Tegula rugosa: "A rude, rugose species, like C. aureotinctum; but much less coarsely sculptured, . ." It is true, the radiate plications on the whorls are similar to the regular sculpture of T. aureotincta (Forbes, 1852) but this, to my eyes, is the only similarity between the two species. It appears to me more similar to the variant in T. brunnea (Philippi, 1848) which Dall named twice, first in 1871 and then again in 1919: fluctuatum and fluctuosus, respectively. In a previous article of this general series of studies (Stohler, 1958) I showed that in T. brunnea the character under discussion varied from about 4% to about 28% in different populations. At that time I suggested that the sculpture of the exceptional specimens of T. brunnea indicated the possibility of parallel evolutionary trends and that the character may, or may not, eventually, occur in every individual of a population. My observations in T. rugosa seem to me to fit into the general thought expressed in that paper; the rather small percentage of individuals showing the trait seems to support the view that we are dealing with a mutation. It might be considered surprising that the exceptional character was noted in all the early descriptions and even in as recent a work as Keen's (l. c.) excellent book it is referred to as if it were the usual occurrence. To be sure, Pilsbry did state (l. c., p. 173, line 8): ". . . , sometimes nearly smooth; " Our samples would suggest rather the reverse description, i. e. "smooth, sometimes with oblique ribs."

Shape: As noted above, the juvenile shells are much more obese than the adult shells. However, in a random sample of a population, such as the one mentioned before, comprising 200 specimens, a great variation in the shape of the adult shell will be noticeable. Figure 2, in addition to showing variation in the umbilical region, also illustrates some of the extremes encountered in the general shell shape. The relatively tall shell is comparatively rare in occurrence but is encountered frequently enough to be worth noting in a comprehensive description of the species.

Color: As already mentioned, color appraisal is subject to great variation due to the optical sense of the beholder as many subjective factors must enter into ascertaining of the color. Also already mentioned is the fact that the shells appear to me as green rather than as ash gray. However, comparing actual specimens with the colors in Maerz & Paul (1950) the following showed complete agreement:

Figure 3: *Tegula (Omphalius) rugosa* (A. ADAMS, 1853)

Lateral and ventral aspects of a specimen collected January 24, 1959, on rocks approximately 30 miles south of San Felipe, Baja California, Mexico.

This specimen shows the "coarse, oblique plications" (see text)

ex coll. Department of Zoology, University of California, Berkeley. x 1.0

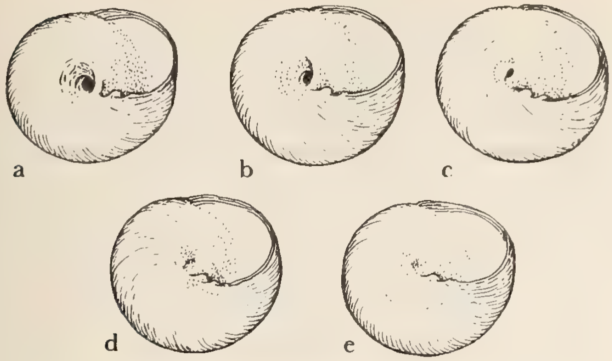

Figure 4: *Tegula (Omphalius) rugosa* (A. ADAMS, 1853)

Ventral aspects of five specimens collected January 24, 1959, on rocks approximately 30 miles south of San Felipe, Baja California, Mexico.

These shells show the various possible conditions of the umbilical area:
a: wide open; b: with fold;
c: pit; d: depression; e: imperforate.

ex coll. Department of Zoology, University of California, Berkeley. x 1.0

General shell color: Pearl Gray (M & P, plate 44, field 1 A) with green in the uneroded areas; the green varied, in different specimens, from M & P, pl. 22, field 1 I to pl. 22, field 6 L (which latter is called Peridot Green). The specks, rather than "lines" of some authors, appear to be pure black to purple (M & P, pl. 44, field 5 F). I failed to see any red markings anywhere. The lip of the aperture is bordered by a green band (M & P, pl. 22, field 7 A to pl. 22, field 5 A; the first of these is called American Green). The outermost edge of the lip, being thin, appears translucent with a yellowish tinge. I failed to encounter any truly brown (Adams, l. c.) or black to purple (Fischer, l. c.) color in my lots.

On the basis of the observations recorded above, the following amplified and emended description is offered:

Tegula (Omphalius) rugosa (A. ADAMS, 1853)

Shell top shaped, heavy, solid; umbilicus wanting to wide open and in the majority of specimens deep, white within; adult shell slightly to much higher than wide, usually eroded; dull green to pearl gray, flecked with black to purple spots; eroded areas may be white to yellowish; whorls rounded, variably sculptured with spiral threads; some specimens have faint to pronounced oblique folds; body whorl appressed at the suture to the penultimate whorl; aperture oblique, rounded; columella with two teeth in the upper half, the upper tooth much stronger and more prominent than the lower tooth; columella curved above the teeth, its callus in many cases spreading and narrowing the umbilicus; inside of aperture nacreous, bordered with a green to bluish-green band, about 1 to $1\frac{1}{2}$ mm wide, the extreme edge of the lip thin with a yellowish-green translucent color. The juvenile shell differs in that it is wider than high; body whorl is not appressed to the penultimate whorl; spiral threads distinct, usually a large one alternating with a small one; nepionic whorls usually eroded, white. The animal possesses four filamentous epipodial tentacles on each side of the foot, which is green in color; the color appears as criss-crossed short lines rather than a uniform patch of color; head and tentacles are also dark green.

Acknowledgment

I wish to express my appreciation to all those many individuals who have assisted this study in one way or another, be it through the gift or loan of specimens, be it through discussion and criticism. But a special word of thanks is due to Mrs. Emily Reid, Staff Artist, for the excellent illustrations reproduced here and those yet to be published.

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Notes & News

A New Marine Research Station at Guaymas, Mexico

BY

BRUCE CAMPBELL

In August 1962 a group of doctors and university professors interested in marine biology and promotion of research organized and incorporated as a non-profit corporation in the State of California under the name of "Sea of Cortez Marine Research Center". Collectively, this group has made in excess of 150 trips to the Gulf of California and points south. Several individuals are past members of a research organization that has worked extensively in such widely separated places as the Marshall Islands, Red Sea, and the Galapagos.

It was felt that a research center in the area being investigated should be established so that scientists can work up their material as it is collected or observed and avoid the plague of collecting huge quantities of specimens only to have it sitting around gathering dust until someone, perhaps years later, has time to study it.

Plans have progressed to the point where a large portion of land, located on the shore of a small protected cove on the northern part of Bacochibampo Bay, Guaymas, Mexico, has been made available by the civic leaders in Guaymas. This has been purchased by the group, and through town officials, friends in the government, and Captain Xavier Mendoza, a director of the group, yards of "red tape" have been cut so that as money becomes available building can be started on the "Center" proper. It will be designed so that living quarters can be provided for visiting workers, and adequate laboratory space can be adapted to various projects. Plans call for aquaria that will be at the disposal of investigators. Future plans include field stations in remote areas and an oceanographic vessel. This new facility will be open to any qualified investigator working in any field of biological or physical science.

Sixteenth Annual Meeting American Malacological Union Pacific Division

The 1963 meeting of the Pacific Division of the American Malacological Union will be held on the campus of the University of California at Santa Barbara, June 26 through June 29, inclusive. Reservation blanks and a Call for Papers will soon be in the mail to members.

Anyone interested in malacology or conchology is welcome to attend. Membership in the A. M. U. is invited; annual dues are \$3.00, with an extra \$1.00 for each additional member in a family. Another 50¢ is charged for Pacific Division members; this goes toward defraying the separate costs of the western meetings.

Non-members of the A. M. U.-P. D. who wish to be placed on the mailing list of the Pacific Division may send their names and addresses, together with 50¢, to Mrs. Fay Wolfson, Treasurer, 3336 Poe Avenue, San Diego 6, California.

As we anticipate a large attendance, all who plan to attend are urged to send in their reservation blanks as soon as possible. Many interesting papers have been promised, and several overseas collectors have indicated their plans to be with us this year. You may meet some of your foreign correspondents for the first time in person — don't miss this meeting!

Crawford N. Cate, Chairman
A. M. U.- Pacific Division

Books, Periodicals & Pamphlets

A REVISION OF THE SPHAERIIDAE OF NORTH AMERICA (MOLLUSCA: PELECYPODA)

by H. B. Herrington

Misc. Publs., Mus. Zool., Univ. Michigan, No. 118, pp. 1-74, pls. 1-74, April 26, 1962.

This important analysis of the freshwater "finger-nail" and "pea" clams of North America is a landmark in the study of a most difficult but prolific group of small bivalved mollusks in which utter chaos, both systematic and taxonomic, has existed for decades. With this paper in hand, one is at long last furnished with the means of identifying species under a workable classification based upon relatively simple criteria of shell and hinge characters.

No one who has not attempted to work with these small clams can possibly appreciate the tremendously painstaking job the Rev. Dr. Herrington has accomplished—a task he started in 1938. From the plethora of names given to species in the genera of Sphaerium and Pisidium, Dr. Herrington finds 12 species of the former and 22 of the latter genus valid for the North American continent. To illustrate the mass of species names that had to be considered, take the widespread S. striatinum (Lamarck, 1818), for example, which has 21 listed synonyms; an even more striking situation is found in P. casertanum (Poli, 1791) under which no less than 41 synonyms appear, of which 31 are attributed to the late Victor Sterki, a prolific worker in the group for more than 25 years beginning before the turn of the century.

A more detailed analysis of the distribution of sphaeriids for our three Pacific Coast states gives the following number of species:

	Sphaerium	Pisidium
California	3	11
Oregon	3	6
Washington	5 (6?)	11

These numbers are probably not final as additional collecting, especially in Oregon, is very likely to add more species not yet reported as living in these West Coast states.

Technically, Herrington's "Revision" is excellent and full of necessary yet concise information. He discusses the influence of habitat on the shell (an important consideration in view of great individual variation within a species), both geographic and geologic distribution, and includes a good key based upon shell characters for use in identification. The systematic treatment of species is consistent throughout. It includes measurements of authentic specimens, diagnostic characters, comparisons with other species, habitat, and geographic distribution in Canada, the United States, and Mexico. Fossil records are noted. The work is concluded with a list of described species with their present-day equivalents, a glossary of the morphological terms used in diagnosis, and what appears to be a complete bibliography. The plates are well done, especially those dealing with hinge characters, which one must study carefully in order to identify species. Inclusion of type localities and the location of the type specimens of each valid species would have been helpful to subsequent students of the group, but lack of this information hardly detracts from the general excellence of the work.

AGS

BETWEEN PACIFIC TIDES

by Edward F. Ricketts and Jack Calvin

Third edition, revised by Joel W. Hedgpeth. Stanford University Press, 1962. 516 pp. $8.75.

This long-lived classic is here presented in a new edition. As the editor points out in a brief prefatory note, the book is now 23 years old, and much has changed. Some of the changes are duly noted in the revisions and additions to the annotated bibliography, but the original text by Ricketts remains for the most part intact. The most conspicuous exception to this is the replacement of the chapter on plankton by a new chapter which attempts to summarize the researches conducted in the last dozen years by

the California Cooperative Oceanic Fisheries Investigations. In most recent years this study has had to take into consideration the implications and possible effects of radioactive materials. Since the shore line — especially between Pacific tides — is a potential region for the concentration of radioactive materials, discussion of this problem is not as far at sea as may first appear. In any event, this chapter, "Beyond the tides: the uncertain sea", brings together from various sources a summary of information not easily found by those who do not make it a profession to keep up with the growing flood of technical literature. In it the reader will find discussions of the California current system and the events of the last ten years along our shores — and of the complex interrelations of plants, animals, and water that professional scientists call the ecosystem.

The book as a whole remains a "must" for every serious student of marine biology, be it in California or anywhere else in the world.

RS

NEW NAMES INTRODUCED BY H. A. PILSBRY IN THE MOLLUSCA AND CRUSTACEA

by William J. Clench and Ruth D. Turner

Academy of Natural Sciences of Philadelphia, Special Publication No. 4. 218 pp. 1962. $5.-, postpaid in the United States, $5.50 elsewhere.

Not only did Henry Augustus Pilsbry live a long time, he also was productive for an almost unbelievably long time. He published, during a span of 75 years, a total of 1,151 papers and created 5,680 new names. Many students of mollusks may not be aware that Pilsbry also named many crustaceans, especially barnacles; but other groups of invertebrates also received his occasional attention. All of the Pilsbry names are listed in this book. Its value to all serious workers in the fields of conchology and malacology, as well as to students of crustaceans, cannot be exaggerated.

The names are arranged alphabetically, followed by the "author" — a great help since Pilsbry published many important large works in co-authorship with various other workers. Following this information in each case is the year of publication, the bibliographic reference, and a citation of the type locality. As the authors, Drs. Clench and Turner, point out in the introduction to this compilation, no critical review was intended. That is left to those workers who will encounter the problems as they work on one taxon or another. The authors invite the users of this book to communicate to them any errors or omissions that may be uncovered, as they intend to publish a supplement to this work at a later date.

Anyone who has ever done any amount of bibliographical research can appreciate the herculean task performed by Clench and Turner; for this they deserve high praise and the gratitude of serious students for generations to come.

RS

THE NORTHERN CALIFORNIA MALACOZOOLOGICAL CLUB is a non-profit educational corporation (Articles of Incorporation No. 388588 were filed December 31, 1959 in the office of the Secretary of State). The CLUB publishes a scientific quarterly, the **VELIGER**. Donations to the CLUB are used to defray a part of the production costs and thus to keep the subscription rate at a minimum. Donors may designate the Fund to which their contribution is to be credited: Operating Fund (available for current production); Savings Fund (available only for specified purposes); Endowment Fund (income only available). Unassigned donations will be used according to greatest need.

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THE VELIGER is open to original papers pertaining to any problem concerned with mollusks.

This is meant to make facilities available for publication of original articles from a wide field of endeavor. Papers dealing with anatomical, cytological, distributional, ecological, histological, morphological, physiological, taxonomic, etc., aspects of marine, freshwater or terrestrial mollusks from any region, will be considered. Even topics only indirectly concerned with mollusks may be acceptable. In the unlikely event that space considerations make limitations necessary, papers dealing with mollusks from the Pacific region will be given priority. However, in this case the term "Pacific region" is to be most liberally interpreted.

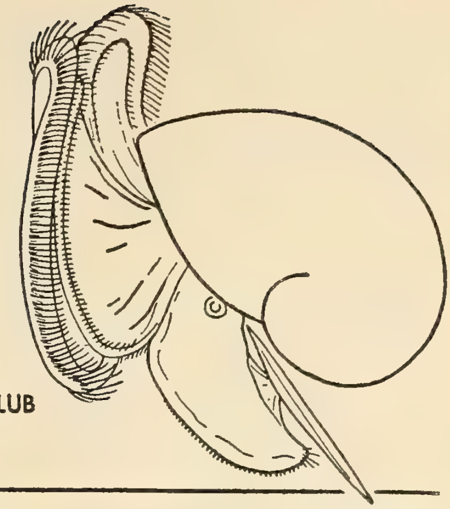
It is the editorial policy to preserve the individualistic writing style of the author; therefore any editorial changes in a manuscript will be submitted to the author for his approval, before going to press.

Short articles containing descriptions of new species or lesser taxa will be given preferential treatment in the speed of publication provided that arrangements have been made by the author for depositing the holotype with a recognized public Museum. Museum numbers of the type specimens must be included in the manuscript. Type localities must be defined as accurately as possible, with geographical longitudes and latitudes added.

Short original papers, not exceeding 500 words, will be published in the column "NOTES & NEWS"; in this column will also appear notices of meetings of the American Malacological Union, as well as news items which are deemed of interest to our subscribers in general. Articles on "METHODS & TECHNIQUES" will be considered for publication in another column, provided that the information is complete and techniques and methods are capable of duplication by anyone carefully following the description given. Such articles should be mainly original and deal with collecting, preparing, maintaining, studying, photographing, etc., of mollusks or other invertebrates. A third column, entitled "INFORMATION DESK," will contain articles dealing with any problem pertaining to collecting, identifying, etc., in short, problems encountered by our readers. In contrast to other contributions, articles in this column do not necessarily contain new and original materials. Questions to the editor, which can be answered in this column, are invited. The column "BOOKS, PERIODICALS, PAMPHLETS" will attempt to bring reviews of new publications to the attention of our readers. Also, new timely articles may be listed by title only, if this is deemed expedient.

Manuscripts should be typed in final form on a high grade white paper, 8½″ by 11″, double spaced and accompanied by a carbon copy.

THE VELIGER



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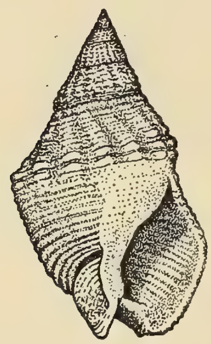

Note: The various taxa above species are indicated by the use of different type styles as shown by the following examples:

ORDER, Suborder, **DIVISION, Subdivision,** SECTION,

SUPERFAMILY, FAMILY, Subfamily, *Genus*, (*Subgenus*).

Further Remarks on Two Rare Cowrie Species (Gastropoda)

BY

FRANZ ALFRED SCHILDER

University of Halle (Saale), German Democratic Republic

Zoila venusta (Sowerby, 1846) and its ally Z. episema Iredale, 1939 (Cypraeidae) recently have been treated by C. N. Cate (1962) in a paper excellent both with regard to the complete review of the history of these cowries, as well as to the descriptions of their morphological characters.

In the decade before World War II, I have personally examined the only three specimens of Zoila venusta preserved in collections of Europe; they are tabulated in Table 1.

Sowerby (1846) stated that the holotype of Cypraea venusta had been "received" from Port Adelaide, but he did not assert that it had been really collected there: therefore, its real habitat should be regarded as unknown, as the species surely does not live in eastern South Australia. Cox (1869) indicated that C. thatcheri had been collected in the Dampier Archipelago, but subsequently Brazier (1882) corrected the type locality to Cervantes Island (his quotation of the width of the shell is evidently a misprint); Cate (1962, p. 9) thought the latter habitat should be adopted, whereas I prefer the former locality, as Cervantes Island is too close to the area inhabited by Zoila episema, and one might wonder that not more than four specimens of Z. venusta (the young "var." bakeri Gatliff, 1916, included) have been collected in this far better known area.

Cox (1869) possessed two specimens of Cypraea thatcheri said to be "exactly alike in every way"; he did not designate a holotype, but I think the shell figured in his original publication should be regarded as holotype. This shell which Cox had sent "to be figured" evidently remained in his collection until it was sold in 1904 by Sowerby and Fulton to Dautzenberg who expressly stated his shell to be the specimen figured by Cox; the minor differences between Dautzenberg's shell (Cate, 1962, Pl. 4) and Cox' figure mentioned by Schilder & Schilder (1952, p. 176) may be explained by inexact freehand

Table 1

Nomenclatural Status	Collection	Formula[1]; dorsal spots	Figure
Cypraea venusta Sowerby, 1846 holotype	Saul, now Museum University Cambridge, England	71 (62) 28 : 16 oi	never figured
Cypraea thatcheri Cox, 1869 holotype	Dautzenberg (received from Cox), now Museum Brussels	74 (63) 25 : 15 lh	Cox 1869, copied by Roberts 1885; new photograph in Cate 1962, pl. 4
Cypraea thatcheri Cox, 1869 paratype	British Museum (received from Cox)	76 (61) 26 : 17 mi	Sowerby 1870, copied by Weinkauff 1881 and approximately by Allan 1956

[1] The formula indicates the length of the shell (in millimeters), the relative breadth (in per cent of length, in parentheses), the absolute number of labial and columellar teeth (separated by a colon), and the relative closeness of labial and columellar teeth (as explained in Schilder, 1958)

drawing of the latter, especially for the purpose of making the shell appear more regular with regard to the distribution of dorsal spots, the number of which was increased. This view is supported by the fact that according to Sowerby (1870, p. 19) Cox sent the other specimen to the British Museum, and that he did so very soon, as this paratype was figured only one year after the original publication (pl. 2 of Sowerby's Thesaurus, published in 1870). The formula calculated from Cox' original description [76(65)24: 14 lg] does not agree with either specimen, but this fact may be explained by inexact measuring and different counting of the teeth.

* * *

Cate (1962, p. 13) has carefully described the differences between a recently discovered shell from West Wallaby Island in the Houtman Abrolhos Archipelago, thought to be Cypraea venusta, and the far more frequent C. episema living farther south. But these characters do not agree with the three adult Zoila venusta tabulated above, whereas these three real Z. venusta agree with Z. episema in all characters except that the columellar teeth are less obliterated in most specimens of the latter, the general color is much paler with the margins pinkish instead of greyish, and the spots reduced. Such superficial characters (as tabulated below) surely should be regarded as racial only; therefore, I have separated Z. episema as good species from Z. thersites (Gaskoin, 1849) in 1960, and I have united it with Z. venusta in my list of cowrie species in 1961.
[According to Iredale (1935), Gaskoin's paper printed in the volume for 1848 of the Proc. Zool. Soc. London in fact was published in March 1849, so that the correct data of Cypraea thersites, C. bicolor, C. gracilis, C. labrolineata, and C. pallidula are 1849, instead of 1848, as well as those of C. obscura, C. sulcata, C. vitrea, and C. grando now belonging to the family Triviidae.]

Among Zoila venusta episema with large dorsal spots and greyish, distinctly spotted margins, there are two different kinds of specimens: the typical large Z. episema from Cape Naturaliste (type locality) and Geographe Bay, and a consistently smaller variety with still darker and confused dorsal markings which evidently lives farther north and has been separated as "Sorrento Reef variant" by Cate (1962, p. 12). There is a distinct gap between the range of size in eleven specimens of this northern variant (53 to 65 mm) and seven southern real Z. episema (75 to 81 mm), so that I should like to recommend the replacing of Cate's term "Sorrento Reef variant" by a Latin racial name.

Zoila venusta sorrentensis SCHILDER, subspec. nov.

Holotype: Formula 59(62)24:17 mk, dorsum nebulous pale chestnut with dark chestnut blotches, margins greyish pink with small brown spots, extremities pinkish grey, base whitish, teeth yellowish.

Type Locality: Collected at Sorrento Beach near Fremantle, 7 January 1962, by B. R. Wilson and presented by Ray Summers to coll. Schilder (No. 13344).

Paratypes: The hypotypes 3, 4, and 8 to 13 of Cypraea episema quoted by Cate (1962, p. 7) have been partially mentioned (but not figured) by Schilder (1960, p. 186).

Therefore, Zoila venusta should be divided into three geographical subspecies, which can be listed as follows (Table 2).

The differences of the geographically restricted races concern size and color only, but there is no constant difference in shape and in the structural features of the dorsum, extremities, margins, base, aperture, dentition, and fossula; the posterior columellar teeth possibly are more developed in Zoila venusta venusta than in the other two races.

Morphologically, Zoila venusta sorrentensis is an extreme race, connected with the other extreme, Z. v. venusta, by the intermediate Z. v. episema. Phylogenetically, Z. v. sorrentensis seems to represent the most primitive race, which has developed two progressive descendants with some parallelism in characters, spreading from its central habitat both to south (Z. v. episema) and north (Z. v. venusta) and thus constituting the "wedge" between the two larger and paler races. But nomenclatorially, Z. sorrentensis and Z. episema must be treated as subspecies of Z. venusta according to the rule of priority.

* * *

The specimen from West Wallaby Island called Cypraea venusta by Cate (1962, p. 7), however, is quite different from the specimens discussed above. Cate has described the differences between Zoila episema and his C. "venusta" in an admirably exhaustive way, but they really refer to Z. venusta (including episema

Table 2

Name:	*Zoila venusta sorrentensis* SCHILDER, subsp. nov.	*Zoila venusta episema* IREDALE, 1939	*Zoila venusta venusta* SOWERBY, 1846
synonyms:	*episema* SUMMERS, 1961 "Sorrento Reef variant" CATE, 1962	*venusta* var. COX, 1889 *brunnea* (emend.) HIDALGO, 1906 (preoccupied) *venusta* SUMMERS, 1961	*thatcheri* COX, 1869 *bakeri* GATLIFF, 1916 ——
hypotypes of *episema* in CATE, 1962, p. 7	No. 3, 4, 8, 9, 10, 11, 12, 13	No. 1, 2, 5, 6, 7	
photographs in CATE, 1962	plate 3, figs. 2, 3	pl. 2, figs. 2, 3; pl. 3, fig. 1	plate 4, figs. 1, 2, 3
other photographs	——	IREDALE, 1939, plate 27, figs. 3, 4 SCHILDER, 1960, plate 14, fig. 1	——
inhabited part of Western Australia	central (Fremantle: Sorrento Reef)	southern (Geographe Bay, Cape Naturaliste)	northern (probably Dampier Archipelago)
specimens (or their illustrations) examined	11	7	4
length in mm, mean and (range)	59 (53-65)	78 (75-81)	73 (71-76)
breadth in %, mean and (range)	64 (62-67)	65 (61-69)	64 (61-70)
labial : columellar teeth mean	22 : 15	24 : 17	26 : 16
closeness of teeth, mean and (range)	l : i (i - n) : (g - k)	l : i (k - n) : (h - k)	m : i (l - o) : (h - i)
dorsal ground color	hidden	whitish	pinkish
dorsal blotches	confusedly confluent	partially confluent	discrete
margins (at extremities)	greyish	greyish	pink
margins	spotted	spotted	unspotted
teeth	brownish	paler brownish	whitish

and sorrentensis) and a new species, which I propose to call:

Bernaya catei SCHILDER, spec. nov.

Holotype: The unique shell [formula: 76(65)23: 17 (not 16) ki] figured by Cate (1962) on Plate 1 (in color) and on Plate 2, the two lowermost photographs (to be called figure 1).

The chief specific differences may be tabulated once more as follows (Table 3).

Several superficial characters, as the dorsal line and the transverse striae of the outer lip, seem to approach Bernaya catei to Zoila thersites (Gaskoin, 1849) from South Australia. Most essential characters, however, especially the symmetrical profile line in lateral view, the less angular margins, the straight aperture, the more primitive outlets, the well developed columellar teeth sloping inward, etc., seem to point rather to the genus Bernaya than to Zoila (Schilder, 1941, pp. 80-81). This genus seems to have become extinct in Eocene times, as the two most primitive cowrie species, B. teulerei (Cazenavette, 1846) and B. fultoni (Sowerby, 1903), are more pyriform than globular and therefore they belong to the subgenus Protocypraea. The photograph of B. catei published by Cate (1962) on Plate 2 (lowermost figures) surprisingly agrees with B. media (Deshayes, 1835) from the Eocene of France, and it also recalls

Table 3

Name of species:	*Bernaya catei* SCHILDER, spec. nov.	*Zoila v. venusta* (SOWERBY, 1846)
general shape	globular	subpyriform
maximum height	central	posteriorly
anterior extremity	steep (as the rear)	sloping
marginal edges	rather rounded	more angular
base	rather convex	flattened
base in front	less impressed	concave
base along aperture	sunken, rounded	rather angular
aperture in front	less dilated	much dilated
aperture behind	rather straight	much curved
anterior outlet	rather vertical	oblique
same seen from base	less emarginate	deeply emarginate
columellar teeth	extended inward though the fossula itself is smooth	restricted to the margin of the aperture
anterior columellar teeth	rather small, short, transversal	larger, elongate, oblique
posterior columellar teeth	rather developed	mostly obsolete
paler dorsal line	well developed	absent
lateral spots	few, on the right side only	well developed on both margins (in dark races only)
lateral striae	vertical	transversally marmorate in all races
brownish color on the outer lip	transverse striae produced across the lip	mostly restricted to the teeth themselves

B. cavata (Edwards, 1865) from the Eocene of England, of both of which I possess well preserved shells; but B. catei is much larger, approaching in size to B. baluchistanensis (Noetling, 1897) from the Upper Cretaceous of Pakistan and Libya, and to B. brevis (Douvillé, 1920) from the Eocene of Nigeria, of both of which only internal casts are known (one cast of each also in the writer's collection). Therefore, B. catei should be classified as Bernaya (s. str.), though some characters tend towards Zoila.

Among extinct species, some more cowries connecting Bernaya (distributed along the Paleogene equator of the Eastern hemisphere) and Zoila (evidently restricted to the eastern border of this area): besides the poor remains of B. zoiloides Schilder (1958) from the Eocene of New Zealand, there are the well preserved shells of Z. schilderi Dey (1941) and Z. gendinganensis (Martin, 1899) from Upper Miocene and Pliocene beds of India and Java, respectively, which show still many characters of Bernaya. Zoila platypyga (McCoy, 1876) and its allies from the Miocene of Victoria, however, are real Zoila (with strong teeth recalling Lyncina sulcidentata (Gray), and Z. kendengensis Schilder (1941) from the Pleistocene of Java seems to be a tropical antecessor of Z. friendii (Gray).

The recently discovered living Bernaya catei seems to represent another link connecting Bernaya with Zoila, so that one should consider degrading Zoila to a subgenus of Bernaya. At any rate B. catei represents the most ancestral living cowrie species, which I am glad to connect with the name of our very zealous promotor of cypraeology.

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Additional references are quoted on page 14 in Cate, 1962.

Insular Haliotids in the Western Pacific (Mollusca : Gastropoda)

BY

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(Plate 14)

References pertaining to the distribution and classification of the Sea Ears or Abalone (family Haliotidae) found on the islands of the far Western Pacific are widely scattered. The most recent monographic work on this family is that of Pilsbry (1890) in the Manual of Conchology. Since then, although there have been a number of interesting papers, chiefly local lists or descriptions of new species, no attempt seems to have been made to cover this region on a taxonomic or distributional basis. The present paper, therefore, may be of value to malacologists and biologists working on the marine fauna of this vast region.

GEOGRAPHICAL AREA COVERED

Abbott (1960) in his work on the genus Strombus discussed these islands and used the term "Pacific Arc". The distribution of the haliotids in this region appears to be similar in a number of aspects to that of the strombids from the Ryukyu Islands, near Japan, south and east through the Philippine and Indonesian archipelagos, to the islands and atolls of Melanesia, Micronesia, and southern Polynesia. This area constitutes a gigantic arc of islands covering most of the far Western Pacific Ocean. Certain species occur on the coasts of the major land areas of Australia, but here they appear to be only extensions of the range from the insular arc. We find series of endemic species in the Coral Sea and on the Barrier Reef of Australia, and two additional species, normally considered Australian, range into the Indonesian-Philippine Island area. Some questions have arisen as to the status of the far western major islands of Indonesia, Java, and Sumatra, but their marine fauna seems to place them well within the major area covered by this paper. Thus, the geographical scope of this paper is delineated.

FOSSIL RECORDS

The family Haliotidae is known from Japan, Australia, New Zealand, and California by fossil records, chiefly from the Miocene to the Recent. (There is also one Cretaceous record from California.) As far as could be determined on the basis of paleontological material available, there has been little change in the shell characteristics. The volcanic or high islands would be devoid of fossil specimens, except perhaps on relatively recent elevated shore terraces. It might be quite possible that some of the cores from the atolls or low islands would contain such specimens. Geological evidence now indicates that these sinking islands have been in existence since later Tertiary times, and as we know the family was well established over much of its present geographical range during the same period, it is quite probable that fossil data will turn up in due time.

METHODS AND MATERIAL

Certain named species were keyed out by the use of the soft parts as well as the shell. It had been found by Ino (1953) and Talmadge

(1957-58) that, although there is considerable variation in the shell due to age, ecological conditions, individual variations, and geographical distribution, the soft parts remained constant within a species. Thus, specimens that appear to belong to two distinct species actually could be only variations of a single widely distributed species. Identifications of many of these were verified by direct comparison with type material. Specimens were sent, for example, to the British Museum (Natural History) and compared with the original lots of Reeve, Sowerby, and others.

Major collections — museum, university, and private — were examined in an effort to determine the geographical races of various species, as well as their respective ranges. Many lots examined were simply labeled as "Japan", "Philippines", or "Pacific Islands"; these were disregarded for obvious reasons. Only lots with a collecting locality that could be plotted on a distributional map were utilized.

BIBLIOGRAPHY AND SYNONYMY

The bibliography listed for each species is far from complete. Works that would be available in most museum and university libraries are given preference. Certain publications are listed for historical reasons. One nonscientific publication that was available to the armed forces and is to be found in most small private libraries is listed.

Under each species I list the synonymy maintained in my collection. There probably will be some question as to the identification and status of some of these, and for this I assume full responsibility. Taxonomic classification is an artificial series of units set up by scientists for their convenience, and seldom do we find two taxonomists with identical opinions. Therefore, the never-ending question of classification will not be settled by this paper. Perhaps in time additional information may prove some or all of my interpretations to be in error.

Acknowledgment

I am grateful to the curators of several museum and university collections, both in the United States and abroad, for making the collections in their care available to me. Special appreciation is expressed to Drs. Leo G. Hertlein, R. Tucker Abbott, J. P. B. Morrison, A. Myra Keen, Rudolf Stohler, and Takashi Ino, for discussing problems relating to this project. Mr. S. P. Dance of the British Museum (Natural History) generously devoted much of his time for direct comparison of specimens with the type material in its historical collections. There were a number of dealers who became interested in this project and went out of their way to obtain specimens with the soft parts preserved, together with accurate locality data. There were also a number of private collectors who did the same. Most of these wish to remain anonymous, so I can only express my general appreciation. Major collections will be listed at the end of this paper.

SPECIATION AND DISTRIBUTION

For convenience I will use a single genus, Haliotis, divided into rather broad subgenera. Some authorities consider these subgenera as of full generic rank. As there have been numerous names proposed and used from time to time, which would only confuse the distributional picture, I have referred only to those which pertained to a single species, referred to as being the type species.

Family: Haliotidae, Rafinesque, 1815
Genus: Haliotis Linnaeus, 1758

Type Species: Haliotis asinina Linnaeus, 1758, subsequent designation, Denys de Montfort, Conch. Syst. 2, p. 119, 1810, under L'Haliotide, Haliotis asininus, "Espèce servant de type au genre". Thus, this interesting, and actually non-typical species is the type species of the genus, and also of the subgenus s. s.

Subgenus: Haliotis s. s. Denys de Montfort
Haliotis (Haliotis) asinina Linnaeus

1758, Haliotis asinina Linnaeus, Syst. Nat. 10, #652.

1810, Haliotis asinina Denys de Montfort, Conch. Syst. 2, p. 119.

1854, Teinotis asinina H. & A. Adams, Gen. Rec. Moll. 1, p. 442.

Type in: Collection of the Linnaean Society of London (?).

Type Locality: As no type locality was given by Linnaeus or Denys de Montfort, and since no other worker seems to have designated a type locality as far as I have been able to ascertain,

and as Linnaeus used Rumphius as his primary source, I hereby designate Amboina, Indonesia, as the type locality. I cannot detect any difference in this species from any locality throughout its range.

Range: Ryukyu Islands (Okinawa); Philippines (all islands); Indonesia (Amboina, now Ambon; Java; Bali); New Guinea (Biak); Solomon Islands (Malaita); New Caledonia (Cook's Reef); Fiji (Suva); Loyalty Islands (Lifu); Mariana Islands (Guam); Caroline Islands (Palau). Records in the literature from Singapore and the China coast need confirmation. This species also ranges into Australian waters, being found at numerous stations along the Barrier Reef as well as in North Australia. Moreover, it is reported from Japan, but specimens from these areas are not included in the present study as the basic range appears to be the islands of the Pacific Arc.

Discussion: The soft parts of the animals are as unique as the shell. The latter forms a shield over the vital organs; the animal is much too large to ever be completely retracted beneath the shell, it being at least twice as long and twice as wide as the shell, as well as being rather deep. The upper portion of the epipodium can be curled over the edge of the shell, protecting the polished periostracum. According to field collectors, this species can control the spread of the epipodium in such a way that, as it plunges into the deeper tidal pools when disturbed, it simulates the gliding flight of the North American Flying Squirrels.

Subgenus: Padollus Denys de Montfort, 1810

Type Species: Haliotis parva Linnaeus. Original designation, Denys de Montfort, Conch. Syst. 2, p. 115, 1810. Denys de Montfort used the name Padollus rubicundus for the type of his genus Padollus. Röding, earlier, had used the same species name and had referred to a figure in Martini which was the orange phase of H. parva Linnaeus. De Montfort's use of the same name, as well as the same locality, together with Iredale's work (1911) on this subject, is a very strong indication that the Linnaean species may be considered the type of the genus. Type species, Padollus rubicundus Denys de Montfort = Haliotis parva Linnaeus. Type locality: "Côtes d'Afrique".

There have been a number of names proposed, either generic or subgeneric, for species of this general form of shell. However, I consider these to be only good species, not warranting higher taxonomic separation. By the use of the conservative approach, all are placed in a single subgenus in this paper.

Haliotis (Padollus) pulcherrima Gmelin, 1791

1791, Haliotis pulcherrima Gmelin, Syst. Nat. 13, #3640.
1846, Haliotis pulcherrima, Reeve, Conch. Icon. 3, Sp. 1, Pl. 1, fig. 1.
1890, Haliotis pulcherrima, Pilsbry, Man. Conch. 12, p. 124, Pl. 13, fig. 69.
1959, Haliotis pulcherrima, Webb, Handbook for Shell Collectors, pp. 128-129, fig. 13.

Type in: ? — Lost?

Type Locality: Presumed to be one of the Gambier Islands "Lord Hood".

Range: Endemic to the Tuamotu Archipelago (Paumotus): Raraka, Raroia; Gambier Islands. I have seen specimens with the label Samoa, but this locality needs verification. There are also Australian records referring to King George Sound (which one?), and these also need definite confirmation.

Discussion: This ornately sculptured and colored shell needs little comment. There is no other small, circular haliotid in the Western Pacific with such sculpturing so that it need never be confused with any other species.

Haliotis (Padollus) dohrniana Dunker, 1882

1882, Haliotis dohrniana Dunker, Novit. Conch., p. 48, Pl. 15, figs. 13-15.
1890, Haliotis dohrniana, Pilsbry, Man. Conch. 12, p. 98, Pl. 7, figs. 38, 40, 41 (see Plate 14, Figure 7).

Type in: ?

Type Locality: New Hebrides Islands (Dunker, Pilsbry).

Range: Except for the type locality, cited by Pilsbry who copied the original figures of Dunker, the only data that I have are based upon three specimens. These are: 1) California Academy of Sciences, San Francisco, locality "New Hebrides"; 2) Bogor Museum, Bogor, Java, labeled only "Dutch East Indies"; and 3) Talmadge Collection, labeled "Formosa".

Discussion: I have not seen the soft parts of this little-known species, nor do I have any additional information on it. Specimens labeled with this name have been received from time to time, but in all cases they have proved to be Haliotis planata Sowerby. Based upon the three

specimens examined, I place the species in the subgenus Padollus, although there are a number of features that do not agree with this general classification. What the exact taxonomic status is remains a question until the soft parts of the animal and larger sets of shells are available for study.

Haliotis (Padollus) ovina Gmelin, 1791

1791, Haliotis ovina Gmelin, Syst. Nat. Ed. 13, #3671.
1846, Haliotis ovina, Reeve, Conch. Icon, 3, Sp. 28, Pl. 9, fig. 28.
1890, Haliotis ovina, Pilsbry, Man. Conch. 12, p. 124, Pl. 19, figs. 7-8.
1943, Ovinotis ovina, Cotton, Trans. Roy. Soc. So. Aust. 67, p. 179.
1959, Haliotis ovina, Webb, Handbook for Shell Collectors, p. 105, fig. 2.

Type in: ? — Lost?

Type Locality: Philippines (Cotton).

Range: Ryukyu Islands (Okinawa); Philippine Islands (Luzon; Samar; Cebu); Dutch New Guinea (Schouten Island); Solomon Islands (Malaita); New Caledonia (Cook's Reef); Loyalty Islands (Lifu); Fiji Islands (Suva); Indonesia (Java, Amboina); Caroline Islands (Palau); Mariana Islands (Guam). Specimens have been examined from southern Japan and the Barrier Reef off the east coast of Australia. There are also records from Malaya and the coast of China, but these appear to be extensions of the basic insular range.

Discussion: Except for individual variations in color, this species is uniform over the known range. Cotton (1943) used the species as the type of the genus Ovinotis. As I consider a genus or a subgenus as a rather broad group of species with similar features, it is difficult to accept the additional taxon, based upon what I consider to be minor features, as in the best interest of general knowledge. It is true that we have a number of strong species and a great number of weak or poorly defined species. However, when we take the family Haliotidae as a whole, and include the comparison of the soft parts, these additional generic units seem not to be appropriate.

Haliotis (Padollus) ruber clathrata Reeve, 1815

1815, Haliotis ruber Leach (partim) Zool. Misc. T. 54, fig. 23.
1846, Haliotis clathrata Reeve, Conch. Icon. 3, Sp. 71, Pl. 17, fig. 71.
1890, Haliotis clathrata, Pilsbry, Man. Conch. 12, p. 116.
1957, Haliotis ruber clathrata, Talmadge, Nautilus, 71 (2), p. 59.

Type in: British Museum (Natural History).

Type Locality: Bohol, Philippines (Reeve).

Range: Indonesia (Bali); Malaya (Singapore); New Guinea (Trobriand Islands); New Caledonia (Cook's Reef); Marshall Islands (Eniwetok); Eastern Caroline Islands (Palau); Phoenix Group (Canton Island); Philippine Islands (Bohol); Australia (Thursday Island; Great Barrier Reef off Cooktown and Townsville).

Discussion: For many years this race was thought to be the juveniles of Haliotis ruber; some authors considered it as a distinct species. However, due to the fact that the shells of H. ruber are consistently smaller and depressed, more rounded and with a stronger suture between the siphonal angle and the left edge, as specimens were obtained from more northern stations along the Barrier Reef, it began to be suspected that we are dealing with a single species rather than two. Comparison of soft parts supports this assumption.

Explanation of Plate 14

Figure 1: *Haliotis* (*Sanhaliotis*) *crebrisculpta* SOWERBY, 1914 (variety). North Keppel Island, off Yeppoon, Queensland, Australia. Figure 2: *Haliotis* (*Sanhaliotis*) *planata* SOWERBY, 1883. Okinawa, Ryukyu Islands. Figure 3: *Haliotis* (*Sanhaliotis*) *exigua* DUNKER, 1877. Okinawa, Ryukyu Islands (topotype?). Figure 4: *Haliotis* (*Sanhaliotis*) *howensis* (IREDALE, 1929). Lord Howe Island, off New South Wales, Australia (topotype). Figure 5: *Haliotis* (*Sanhaliotis*) *varia stomataeformis* REEVE, 1846. North Coast of Java, Indonesia (topotype). Figure 6: *Haliotis* (*Schismotis*) *glabra* GMELIN, 1791. Zamboanga, Philippine Islands. Figure 7: *Haliotis* (*Padollus?*) *dohrniana* DUNKER, 1882. Formosa? Figure 8: *Haliotis* (*Sanhaliotis*) *jacnensis* REEVE, 1846. Okinawa, Ryukyu Islands. Figure 9: *Haliotis* (*Sanhaliotis*) *hanleyi* ANCEY, 1881. Ile Nou, New Caledonia (topotype).

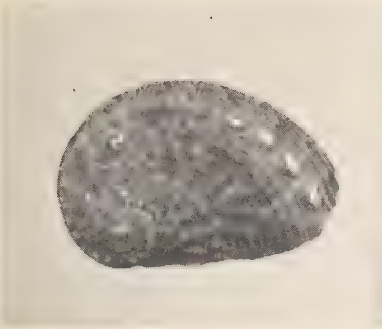

Figure 1

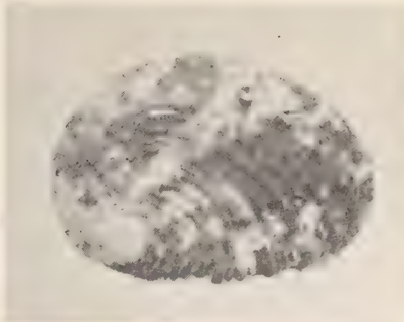

Figure 2

Figure 3

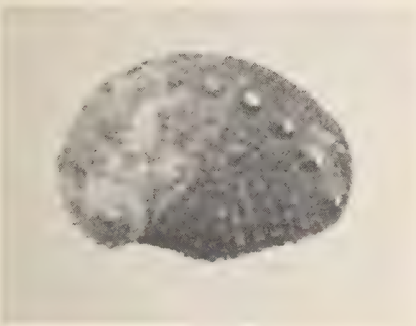

Figure 4

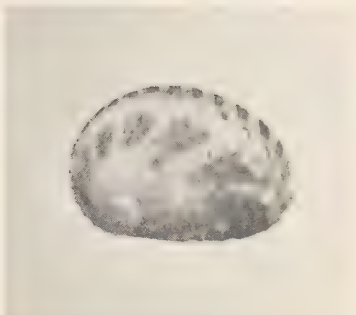

Figure 5

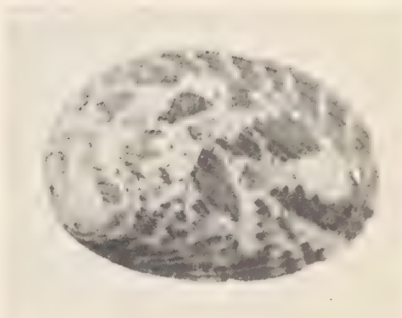

Figure 6

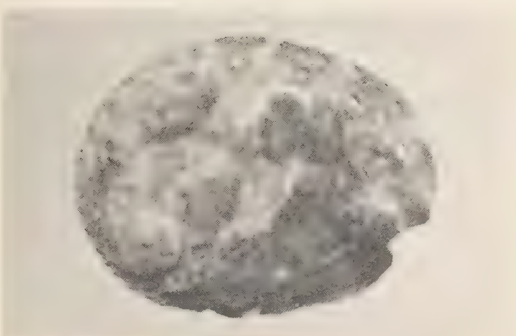

Figure 7

Figure 8

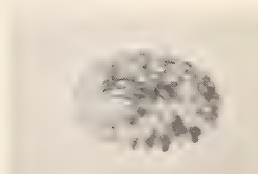

Figure 9

ROBERT TALMADGE, *photo*

Here we have an example of a cooler water species extending its range into tropical waters and also adapting itself to a new ecological biome, that is, changing from a rocky substratum to coral. It is not surprising that the earlier malacologists considered this to be a distinct species or a juvenile. It is extremely difficult to separate many of the juvenile specimens of the typical Haliotis ruber from this northern, tropical race.

Subgenus: Schismotis Gray, 1856

Type Species: By monotypic description, Haliotis excisa Gray, 1856, Proc. Zool. Soc. London, pt. 24, p. 148 (a pathological example, or perhaps the localized cline from Geraldton, West Australia) = Haliotis laevigata Donovan, 1808 = Haliotis albicans Quoy & Gaimard, 1834.

There are three known species of haliotids having great similarities that I place in this subgenus, one of which falls within the scope of this paper. All are noted for the larger number of open siphonal pores, the rim of the pores not being elevated, and the smooth dorsal surface of the shell usually with little attached growth. At times the cording found in juvenile shells is continued into the adult stage.

Haliotis (Schismotis) glabra Gmelin, 1791

1791, Haliotis glabra Gmelin, Syst. Nat. 13, #3690.

1846, Haliotis glabra, Reeve, Conch. Icon. 3, Sp. 2, Pl. 1, fig. 2.

1846, Haliotis ziczac Reeve, Conch. Icon. 3, Sp. 24, Pl. 8, fig. 24.

1959, Haliotis glabra, Webb, Handbook for Shell Collectors, pp. 104-105, fig. 5 (see Plate 14, Figure 6).

Type in: ? — Lost?

Type of Reeve's Haliotis ziczac: British Museum (Natural History).

Type Locality: ? Haliotis ziczac Reeve, Calapan, Philippines (Reeve). Type locality of the nominate form probably is also Philippines.

Range: Apparently only from the Philippine Islands (Luzon; Cebu; Samar; Bohol; Mindoro). There are two specimens labeled "North Borneo" in the collection of the Bogor Museum which are this species. The locality needs verification but is probably correct. Australian specimens labeled Haliotis glabra have all turned out to be the green phase of H. varia Linnaeus; the misidentification was probably caused by a figure in Webb (p. 214, fig. 3) which, although labeled H. glabra, is actually H. varia.

Discussion: Certain examples of this smooth flat species retain the juvenile cording into adult stages, and these were the bases for Reeve's Haliotis ziczac. The coloration is usually referred to as green and cream, with triangular or tent-like markings. Series of shells show that the shell may be concolored or maculated, green, brown, tan, cream, or even pink in any combination.

Subgenus: Sanhaliotis Iredale, 1929

Type Species: By original description, Haliotis varia Linnaeus, Iredale, Mem. Queensland Museum, 9(3), p. 270.

Haliotis (Sanhaliotis) varia Linnaeus, 1758

There has been considerable confusion regarding this highly variable species. Reeve (1846) named, described, and figured as full species a number of color phases, age stages, individual variations, as well as geographical races. Interpretations of these by authors, shell dealers, and collectors, without comparison with the type material, further compounded the confusion. By working with uncleaned, unsorted series which contained the animal parts, I think I now have an understanding of the basic identification and distribution. Selected specimens from various lots were compared with the original material to confirm many of the identifications.

I presently recognize three geographical races or subspecies. Two of these fall within the scope of this study. It has been found that the three races freely interbreed and intergrade at the points of contact. Actually, there is no sharp line separating the races. Rather, we find a gradual transition of features over an extensive area.

Haliotis (Sanhaliotis) varia varia Linnaeus, 1758

1758, Haliotis varia Linnaeus, Syst. Nat. Ed. 10, #650.

1766, Haliotis varia Linnaeus, Syst. Nat. Ed. 12, #1256.

1846, Haliotis varia, Reeve, Conch. Icon. 3, Sp. 4, Pl. 2, fig. 4.

1846, Haliotis concinna Reeve, Conch. Icon. 3, Sp. 66, Pl. 17, fig. 66.

1846, Haliotis semistriata Reeve, Conch. Icon. 3, Sp. 51, Pl. 15, fig. 51.

1846, Haliotis viridis Reeve, Conch. Icon. 3, Sp. 40, Pl. 13, fig. 40.
1855, Haliotis varia, Hanley, Ipsa Linnaei Conch., p. 411.
1890, Haliotis varia var. pustulifera Pilsbry, Man. Conch. 12, p. 96, Pl. 17, fig. 91.
1929, Sanhaliotis varia Iredale, Mem. Queensland Mus. 9 (3), p. 270.
1956, Haliotis varia, Talmadge, Min. Conch. Club So. Calif., 161, pp. 3-7.

Type in: Collection of the Linnaean Society of London (?).

Type: Syst. Nat. 12, Museum Ulricae, Sweden. (Microfilm of type specimens at the Smithsonian Institution, Washington, D. C.)

Type Locality: Philippines, so designated by Reeve, Iredale, and others.

Range: Ryukyu Islands (Okinawa); Philippines (Bataan; north and east coasts of Luzon; east coast of Samar; Leyte; Davao; Cebu*; Zamboanga*); Mariana Islands (Guam); Caroline Islands (Palau); Marshall Islands (Kwajalein); Dutch New Guinea (Schouten and Trobriand Islands); Solomon Islands (Bougainville; Malaita); Papua (Port Moresby*); Loyalty Islands (Lifu); Fiji (Suva); Friendly Islands. (* indicates series of shells which, although they fit into the nominate race, show indications of intergrading with adjacent populations.)

Discussion: The basic race of Haliotis varia s. s. is ovate, small to medium sized, and is highly sculptured with nodes, lamellae, and tubercles. The siphonal pores are moderately elevated crater-like projections, and the spire is somewhat elevated. The color varies; some specimens are concolored, others are rayed, striped, or maculated, in black, green, brown, red, cream, white, or even yellow. There are almost as many color combinations as well as sculpturing combinations as there are individual specimens. Juvenile shells lack the strong sculpturing and are more ovate and depressed.

When plotted on a map the collecting localities turn out to be situated on coasts adjacent to major bodies of deep water. The deep water probably has a tempering effect upon the surface temperatures, which may, in turn, have a definite effect upon the shape and sculpturing of the shell of the nominate race.

The majority of the names proposed by Reeve (1846) apply to color phases only, which may be found in any of the three geographical races. Several other names used by Reeve pertain to distinct color and sculpturing, which seem more or less restricted to Australian waters, not covered in this paper.

Haliotis viridis Reeve is actually a green or green-and-cream colored form of any race of H. varia. Haliotis concinna Reeve may be either red or red-and-white maculated. Haliotis semistriata Reeve has an unusual stripe, and some individuals are black and white, while others are brown and white, as figured by Reeve. A yellow-and-red rayed form was used by Reeve as the basis for his H. papulata, but other details not covered in this paper indicate that the last-mentioned name is under the rules of priority the proper name to be used for the mainland Australian race. However, the color form of red and yellow is found in all three geographical races. The rayed color form of H. varia as figured by Reeve has been considered by Pilsbry as representing the typical species. Hanley (1855) referred to the actual type specimen in the collection of the Linnaean Society of London as being the same as figured by Martini (1790, fig. 144). This is a maculated nodose specimen. The microfilm photograph at the Smithsonian Institution of the type material from the Linnaean Collection in the Museum Ulricae in Sweden also shows a maculated nodose specimen, similar to the figure cited above in Martini. Pilsbry's var. pustulifera is similar, is nodose and maculated, but due to the fine markings, the shell appears uniform. The two types of Pilsbry's variety are in the Academy of Natural Sciences of Philadelphia (Nos. 50179 and 210843, and not from the same locality). Most of Reeve's types are in the British Museum (Natural History).

Haliotis (Sanhaliotis) varia stomatiaeformis Reeve, 1846

1846, Haliotis stomatiaeformis Reeve, Conch. Icon. 3, Sp. 73, Pl. 17, fig. 74.
1890, Haliotis stomatiaeformis, Pilsbry, Man. Conch. 12, p. 89, Pl. 3, fig. 4.
1956, Haliotis varia, Talmadge, Min. Conch. Club So. Calif., 161, pp. 3-7 (see Plate 14, Figure 5).

Type in: British Museum (Natural History).

Type Locality: "Hab. New Zealand" (Reeve). This is obviously an error, as no haliotids of this type have been found in New Zealand waters

as far as I know. A specimen from a set of shells, taken on the north coast of Java, was compared with the type specimen and found to be the same species. Series from the shallow Indonesian seas are fairly uniform and quite similar, except for color. Therefore, I consider it proper to designate a new type locality for Haliotis varia stomatiaeformis Reeve: North Coast of Java, Indonesia.

Range: Indonesia (North Coast of Java; Amboina; Bali); New Caledonia (Cook's Reef); Australia (Darwin; Thursday Island*); Swain's Reef, Coral Sea off Queensland, Australia. (* indicates populations with specimens appearing to intergrade with adjacent populations.)

Discussion: As mentioned under Haliotis varia s. s., certain localities had populations that showed a mixing or merging of populations. The southern and interior Philippine stations are inhabited by a mixed population, exhibiting some specimens more closely allied to the Indonesian race, others more closely related to H. varia s. s. The two northern Australian stations have a similar mixed population, some of the specimens exhibiting characteristics which are Indonesian, others in the same series with definite Australian characteristics.

The typical Haliotis varia stomatiaeformis is a smaller, more elongate, deeper, and smoother shell than the nominate race. It is sculptured with cording only, the nodes and tubercles of the more northern race are lacking, yet the animals are identical in all other features. There is some variation in the strength of the cording but usually only in localized clines. The specimens from Cook's and Swain's Reefs pose a question regarding distribution. Are there two separate areas of distribution for this race, or does the race radiate out of the Torres Strait into the Coral Sea? Specimen material has not been located from other, particularly intermediate, stations between these two separate areas. This is a question that must await further collecting, as at the present time there is no indication of two sibling species, although we seem to have a population isolated from the basic range of the geographical race.

Haliotis (Sanhaliotis) planata Sowerby, 1833

1883, Haliotis planata Sowerby, Thes. Conch. 5, p. 30, fig. 74.

1890, Haliotis planata, Pilsbry, Man. Conch. 12, p. 99, Pl. 11, fig. 58, Pl. 49, figs. 20-22 (see Plate 14, Figure 2).

Type in: ? — Lost?

Type Locality: ? This species appears to have been confused by many authors with Haliotis varia Linnaeus, which in turn has confused the taxonomic and distributional picture. I was unable to locate any definite designation of a type locality. Therefore, as this species appears to be relatively common in the Ryukyu Islands, I hereby designate Okinawa, Ryukyu Islands, as the type locality.

Range: Ryukyu Islands (Okinawa); Philippines (North Coast of Luzon); Solomon Islands (Malaita); Fiji (Suva)?; Indonesia (South Coast of Java = Wynkoops Bay).

Discussion: This flat coral-dwelling species has often been confused with the more common Haliotis varia Linnaeus. The shell is more ovate, the sculpturing more sharply cut, cording stronger, with small sharp nodes. The spire is always depressed, giving the appearance of a small flat, disc-like rough haliotid. Juveniles are extremely difficult to separate, but unlike H. varia, the young of H. planata are somewhat elongate rather than round. Some authors have considered this species to be only a race of H. varia, but the more ornate processing of the epipodium as well as shell features do not bear out this concept.

Haliotis (Sanhaliotis) hanleyi Ancey, 1881

1881, Haliotis hanleyi Ancey, Le Nat. 3(52), p. 415.

1890, Haliotis hanleyi, Pilsbry, Man. Conch. 12, Supp. p. 291.

1929, Haliotis hanleyi, Iredale, Mem. Queensland Mus. 9(3), Pl. 31, fig. 1 (type) (see Plate 14, Figure 9).

Type in: Australian Museum (Iredale).

Type Locality: Île Nou, New Caledonia.

Range: Known only from around Noumea, New Caledonia, possibly only from the type locality.

Discussion: This is another uncommon species. Only three lots are known to me: a series in the San Diego Natural History Museum, a set of three in the American Museum of Natural History, and a set of two in my own collection. Field data indicate that this species inhabits rocks rather than coral and is endemic to the west coast of New Caledonia. It is a small species, 15 to 20 mm long, and is usually more rounded than Haliotis jacnensis Reeve, with which it may be confused. Two features that are probably consistent, which will separate the

two closely allied species, are that in H. hanleyi the right or growing edge of the shell is more smooth, and that the cording in H. hanleyi is very coarse, with a more depressed spire than in H. jacnensis.

Haliotis (Sanhaliotis) exigua Dunker, 1877

1877, Haliotis exigua Dunker, Mal. Blät., p. 69.

1882, Haliotis exigua Dunker, Index Moll. Japan (Novit. Conch.), p. 149, Pl. 6, figs. 8-10.

1890, Haliotis exigua, Pilsbry, Man. Conch. 12, p. 90, Pl. 49, figs. 36-38 (see Plate 14, Figure 3).

Type in: ?

Type Locality: "Japanese Seas" (Dunker).

Range: Known to me only from the Ryukyu Islands (Okinawa).

Discussion: There are two specimens in my collection, both taken from coral crevices on the China Sea Coast of Okinawa. One is scarlet with a few small white maculations, and the other is a pale green with large brown maculations. The original description called for a shell that was chiefly yellow or yellowish. However, I do not know if Dunker's figured shell was taken alive. The lighter colored specimen of my two was a beach shell. Specimens of this may turn up in private collections labeled Haliotis varia Linnaeus, but the shell can be distinguished by being much thinner, smoother, the apex and spire strongly elevated, with the major or bodywhorl rather flat. Dr. Takashi Ino (personal communication) mentions that the species has been recognized by Japanese malacologists and is considered rare in some of the lesser Japanese Islands off the coast of Southern Japan. It is evidently one of the rare species, and little seems to be known other than the original description and figure. The epipodium of the one animal examined was rather smooth, unlike either H. planata or H. varia, which are rather strongly processed.

Haliotis (Sanhaliotis) jacnensis Reeve, 1846

1846, Haliotis jacnensis Reeve, Conch. Icon. 3, Sp. 72, Pl. 17, fig. 73.

1883, Haliotis echinata Sowerby, Thes. Conch. 5, p. 18, fig. 124.

1890, Haliotis echinata, Pilsbry, Man. Conch. 12, p. 89, Pl. 3, fig. 7 (see Plate 14, Figure 8).

Type in: British Museum (Natural History) ? (uncertain).

Type Locality: Jacna, Bohol, Philippines (Reeve).

Range: Ryukyu Islands (Okinawa); Philippines (Luzon; Bohol; Cebu); Mariana Islands (Guam); Caroline Islands (Palau; Truk; Ponape); Marshall Islands (Eniwetok; Bikini; Rongelap; Kwajalein — almost all islands represented); Fiji (Suva); Loyalty Islands (Lifu); New Hebrides (Espíritu Santo); Bismarck Archipelago (Rabaul).

Discussion: This is probably the smallest species of the family, as few examples reach over 20 mm in length. The average runs from 12 to 15 mm long. As certain animals pass into a more or less senile stage, the shell becomes more coarsely corded and rounded, altering into a form which furnished the basis for Sowerby's Haliotis echinata. Such examples are not restricted to any special region within the range of this species. This is a coral-dwelling species, and even on the high islands they are found only on the outer edge of the fringing reef, and on such islands they are not common. They seem to prefer atolls, judging from the large series that were available for study at the Smithsonian Institution. Discussions with Dr. J. P. E. Morrison and the detailed maps available at that museum revealed to me the preference for the coral atolls by this species.

Haliotis (Sanhaliotis) howensis (Iredale, 1929)

1929, Sanhaliotis howensis Iredale, Mem. Queensland Mus. 9(3), p. 270 (see Plate 14, Figure 4).

Type in: Australian Museum (Iredale).

Type Locality: Lord Howe Island, off the coast of New South Wales, Australia (Iredale).

Range: Endemic to the type locality as far as known.

Discussion: Although this island is not in the true sense in the Pacific Arc, it seems to be closely related by the molluscan fauna, especially the primitive species, to the New Caledonia-Coral Sea area. As far as I know, the only material of this species in the United States is in my collection. The shell is deep, elongate, coarsely corded, small, and relatively thick. The cording under a strong magnifying glass resembles the rounded overlapping terra cotta tiles of the Spanish-Californian roofs. The animal is unknown to me. I do not think that the species has been figured.

Haliotis (Sanhaliotis) squamata Reeve, 1846

1846, Haliotis squamata Reeve, Conch. Icon. 3, Sp. 35, Pl. 13, fig. 35.

1883, Haliotis elevata Sowerby, Thes. Conch. 5, p. 27, figs. 116-117.
1890, Haliotis squamata, Pilsbry, Man. Conch. 12, p. 91, Pl. 18, fig. 2.
1890, Haliotis elevata, Pilsbry, Man. Conch. 12, p. 90, Pl. 14, figs. 14-15.

Type in: British Museum (Natural History).

Type Locality: "Northwest Coast of Australia: Dring" (Reeve).

Range: West and Northwest Coast of Australia. Extension into the area covered by this paper: Indonesia (Sunda Straits; Prinz Eiland = P. Paraitan; South Coast of Java = Wynkoops Bay).

Discussion: On the Australian coasts this species exhibits a number of color forms and patterns. In contrast, all of the specimens examined from Indonesian waters were maculated in intense green, brown, and white. Juvenile specimens from the coral of Indonesia are more elongate and retain the lamellae until larger in size, as compared to Australia examples. An extremely elongate shell with strong lamellae is the basis for Haliotis elevata Sowerby, actually more or less of a pathological specimen; this aberrant form has been found a few times.

Haliotis (Sanhaliotis) crebrisculpta Sowerby, 1914

1914, Haliotis crebrisculpta Sowerby, Ann. Mag. Nat. Hist. Der. 8, 14, p. 478.
1929, Sanhaliotis crebrisculpta, Iredale, Mem. Queensland Mus. 9(3).
1961, Haliotis crebisculpta [sic.], Talmadge, The Veliger, 3(4), p. 113 (see Plate 14, Figure 1).

Type in: British Museum (Natural History).

Type Locality: New Caledonia (Sowerby).

Range: Based upon the few specimens available, the range appears to be divided into two widely separated areas. There is one exception which will be noted. The range appears to be the Coral Sea coasts of New Caledonia and Australia, and the Hachijo Jima group north of the Izu Shichito off Southern Japan. The one isolated locality is based upon a specimen from Singapore in the collection of the Academy of Natural Sciences of Philadelphia.

Discussion: Several interesting factors enter into the distribution of this species. Eight specimens of the nominate race were examined, and all were similar. There is also a slightly different population on the islands off the coast of Queensland. Iredale (1929) referred to this species as being found on Michaelmas Island, off Cairns, Queensland, and it may be questioned whether he had the actual Haliotis crebrisculpta s. s. or, instead, the Australian race, which is very similar. Swain's Reef, well offshore from the Queensland Coast, supports an intermediate population. The Singapore specimen presents a problem, as there is no similar species in the Bogor Museum Collection, nor had Dr. Tweedie (personal communication) of the Raffles Museum ever mentioned this species. As far as known, there are no specimen-based records in the area between New Caledonia and the Coral Sea coasts, and the small offshore islands in the north, just south of Japan, with this one notable exception.

Certain species of the genus Strombus, according to Abbott (1960), have similar divided ranges. The hypothesis has been advanced by Abbott that these isolated similar or identical species are relics of a past distribution that has been destroyed or separated by geological forces. The broken distribution of Haliotis crebrisculpta appears to support this theory. Further support and interest is added by the description and figure of a late Cenozoic haliotid from New Zealand, H. powelli Fleming (1952). Although Fleming places this in the revised subgenus Sulculus of H. & A. Adams, 1854, there are many features that would agree with the Recent H. crebrisculpta and H. howensis. It would not be difficult to associate the Australian H. coccoradiata Reeve with this same type of shell. It is possible that there have been a number of broader distributions in the geological past, which have been broken by physical barriers. These in turn could easily have been further divided by other natural events that may have destroyed the populations within certain portions of the race. The similarity of the Japanese and New Caledonian examples of H. crebrisculpta could possibly be explained as relic populations; the intermediate and continuous range of the past may have been destroyed by the volcanic activity of the Indonesian-Philippine region.

Discussion

Most malacologists have attributed the source of the many species in the family Haliotidae to what is generally termed the Indo-Pacific Area. However, closer examination in

the light of detailed distribution and speciation leads me to disagree with this hypothesis. When one considers the possible close relationship of certain African-American-European-Australian species over what some refer to as the ancient land mass of Gondwana and the later Tethys Sea, with the very distinct groupings of species that inhabit the Pacific Arc, the separation appears even more distinct.

If the common source for the family was in the Australian region, why do we find only two Recent species extending their range into the Pacific Arc? One of these we find has only projected its range for a short distance and has not altered its physical appearance. The other, with a much broader distribution, has not only varied the shell features but has also changed the ecological biome. We find four species from the Pacific Arc reaching the shores of Australia, two evolved into geographical races, and two unchanged. In all cases the Australian ranges coincide with adjacent insular areas. Thus, it appears that the present-day Australia actually forms a barrier separating the Recent Indian Ocean species and the Pacific Ocean species, and at the same time has an endemic population of its own. Fossil records, when available, indicate a very strong stability in this family, and it is difficult for me to accept the theory that the Indian Ocean and Pacific Ocean species arose from a common ancestry.

Japanese records for the species found in the Pacific Arc are rather vague; in many cases when malacologists have been asked exactly where in Japan did the material originate, it was found that it was on the "Islands off the South Coast". The Schichito Islands and the Ryukyu Islands appear to me to be the source of such Japanese information, as the species are definitely known from these islands. Species that fall into the major Japanese faunal area appear to turn westward and southward along the coast of China and into the Indo-China region, missing the islands of the Pacific Arc.

When one considers that only a single African species has reached the coast of West Australia, and no Australian species are known from East Africa, it appears that we are faced with a barrier situation. Australia and New Zealand seem to separate, rather than create a common distribution. It now appears that we have four distinct Recent faunal areas pertaining to this family in the Indo-Pacific: East Africa and the Indian Ocean; Australia-New Zealand; Japan-China Coast; and the Pacific Insular Arc.

We may then consider the hypothesis that the speciation and distribution of the family Haliotidae on the islands of the Pacific Arc are of local origin. As both the Philippine and Indonesian archipelagos have the majority of the species referred to as inhabiting this vast region, and as both of these island groups are more or less continuous, the source of the many species may have been in this general area. This region, if I am not mistaken, was never considered to be a portion of the reputed land mass of Gondwana, nor was it a portion of the Tethys Sea. Perhaps in time, as more fossil material becomes available, a much clearer understanding of the origin and early distribution of this interesting family will be had.

* * *

The curators and staff of the following museums and universities opened their collections for study, furnished specimens or data, or made direct comparison with the type material available in their collections.

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American Museum of Natural History, New York, New York.
Australian Museum, Sydney, New South Wales, Australia.
British Museum (Natural History), London, England.
California Academy of Sciences, San Francisco, California.
Chicago Natural History Museum, Chicago, Illinois.
Museum of Natural History, Geneva, Switzerland.
Museum Zoologicum Bogoriense, Bogor, Java, Indonesia.
National Museum of Victoria, Melbourne, Victoria, Australia.
New Zealand Geological Survey, Wellington, New Zealand.
Raffles Museum, Singapore, Malaya.
San Diego Natural History Museum, San Diego, California.
Stanford University, Stanford, California.
Tokai Regional Fisheries Laboratory, Tokyo, Japan.
United States National Museum, Smithsonian Institution, Washington, D. C.
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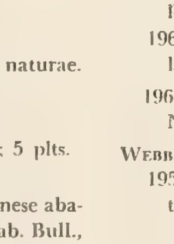

A New Cowrie (Mollusca : Gastropoda) from West-Central Philippines

BY

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(Plate 15; 1 Textfigure)

The renewed general interest in malacology has been worldwide in scope in recent years, but my attention has been drawn in particular to a study of the Philippine Cypraea. Aside from Australasia, there is no area known to have a more varied representation of this genus. Therefore, it was with eager curiosity that I followed personal accounts of the dredging and diving progress of the Palawan Expedition in 1962.

The Palawan Expedition was part of a continuing operation consisting of many short runs and a few longer voyages in two vessels converted by their owner, Mr. James E. Norton of Manila, for the purpose of collecting marine specimens. One of these is a 56-foot U. S. Navy landing barge (LCM-14) converted to a semi-pleasure craft; the other is the M/V Miss Cabalea. This paper will deal only with that part of the enterprise occurring in May 1962 — an extended trip to the southern part of the Philippine Islands in the vicinity of Palawan. Members of the party on this particular segment of the expedition were Mr. and Mrs. James Norton and their two children, Mr. Fernando G. Dayrit, and Mr. Pedro de Mesa, all of Manila; Mr. Robert Lee of Honolulu; and for a portion of the trip, Mr. Phillip Clover, presently stationed in Japan with the U. S. Navy.

After returning to Manila and roughly sorting the material collected on their trip, Mr. Dayrit sent me a specimen of an unfamiliar species of Cypraea for identification, with the comment that he and Mr. Norton had heretofore seen nothing like it in local collections. Searching through my own collection, I found superficial similarities in several species, though no known form was exactly like it, and I was unable to furnish a positive identification. I then requested additional material for study and soon received eight specimens from Norton and Dayrit, and a pair that had been collected by Mr. Lee. I am most appreciative of the willing cooperation of all three men, as the total number of 11 specimens made it possible to determine that the species differs sufficiently from other known Philippine forms to merit specific distinction. It is my understanding that two additional specimens in alcohol still remain in Mr. Norton's possession, to be studied later on by an expert in cypraeid anatomy.

All of the shells of the new species were found by diving in shallow water (three to six feet deep) at the islands of Marily, Demang, Batunan, Inlulucot, and Cagbatan. These five tiny islets are situated within an area less than 20 miles square in Coron Bay, near a larger island, Busuanga, of the Calamian Group which lies to the north of Palawan (see map, Textfigure 1). In all cases, the areas were very rocky and full of living coral; the cowries were found living in crevices, under and on top of rocks, and in the coral itself. Sharing the same habitat were Cypraea lynx Linnaeus, 1758, C. moneta Linnaeus, 1758, C. erosa Linnaeus, 1758, C. arabica Linnaeus, 1758, C. isabella Linnaeus, 1758, C. ovum Gmelin, 1791, C. cribraria Linnaeus, 1758, C. errones Linnaeus, 1758, C. carneola Linnaeus, 1758, and C. vitellus Linnaeus, 1758.

The new species has probably not been previously recognized because of the inaccessibility of its habitat to persons interested in collecting shells; it was only through a special effort such as the diligent searching by Mr. Norton's party (which from time to time included native Moro divers living in the vicinity where the collecting

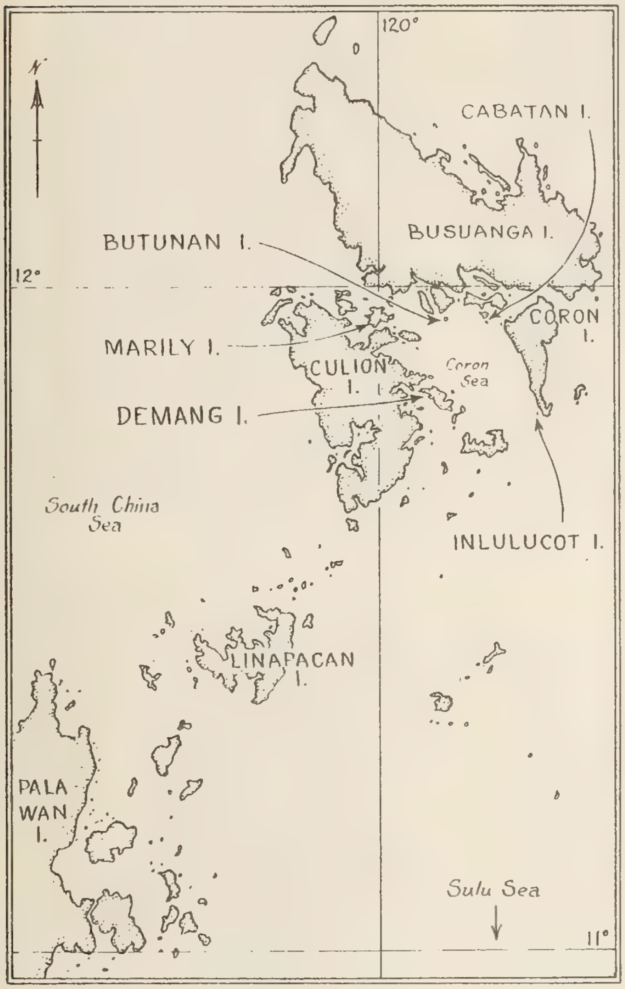

Figure 1

was being done) that it has come to light. At the present time it is not known how far its range may extend, nor how plentiful it may be within that range. The 13 specimens mentioned here are all that are known to this date.

It gives me great pleasure to honor Mr. Dayrit for his extensive work with the Philippine marine shells by naming this new species for him.

Cypraea (Blasicrura) dayritiana C. Cate, spec. nov.

(See Plate 15, Figures 1, 1a, 2, 2a)

Shell short, humped adapically, pyriformly ovate, narrow and constricted anteriorly; base convexly flattened, sides rounded, right and left margins smoothly thickened; aperture fairly straight, narrow, curving sharply left adapically; both terminals produced, front collar broadened, posterior collar more open than usual. Teeth strong, numerous, reaching to both margins, their number about equal on both lips, at least one usually bifid on the columella. Median teeth traverse the fossula adaxially, strongly in front, more or less so in its entire length; terminal ridge rounded and parallel with aperture. Dorsal and marginal inductura smooth, glossy; teeth, interstices, and base dull; apical area cratered around the nucleus; first two and a half whorls are intense brownish black, abruptly changing to the pale creamy white of the basic shell color. Dorsal surface thickly, nearly solidly, flecked with varying intensities of chestnut brown; margins, base, and teeth cream, interstices deeper in color. There is no mantle line.

The type locality is Coron Bay, Calamian Group, north Palawan, Philippines (11° 55' N. Lat., 120° 05' E. Long.). The holotype is deposited in the type collection of the National Museum of the Philippines, Manila, and bears the catalog number NMCO-6766. Paratypes are variously in the collections of Norton, Lee, Cate, and the National Museum, Manila.

Cypraea dayritiana resembles, among other members of the subgenus Blasicrura s. s., C. interrupta Gray, 1824, C. quadrimaculata Gray, 1824, C. pallidula Gaskoin, 1848, and C. pallidula luchuana Kuroda, 1960 (see Plate 15, Figs. 3, 3a), in that these all possess the intense brownish-black nuclear apex.

The new species is of a solid appearance, swelling on both sides, rising toward the middle, humping obtusely adapically, forming a steep incline to the rear with a more gradual incline anteriorly.

In comparison with the above-named species, Cypraea dayritiana seems probably more closely related to C. pallidula luchuana, though differing importantly in many ways. In C. dayritiana the teeth are less numerous and much longer; the base is characteristically dull instead of glossy; it is smaller, more humped and pyriform, whereas C. p. luchuana is larger, flatter, and more narrowly elongate; the coloring in C. dayritiana is deeper, the dorsal pattern more dense; and it lacks the mantle line usually present in C. p. luchuana. Subadult shells of C. dayritiana possess four broad brownish bands equidistantly spaced across the dorsum; this character is more or less common in most immature Cypraeas but seems quite pronounced in this species.

Cypraea dayritiana differs from C. pallidula by the absence of heavy perpendicularly interrupted dorsal bands and by being pyriform instead of cylindrically elongate; from C. interrupta by the lack of obliquely interrupted bands and by being pyriform instead of cylindrically elongate; from C. quadrimaculata in that it is a smaller species, it lacks the four black spots characteristic of C. quadrimaculata (two anteriorly and two posteriorly), and by its darker, denser dorsal coloring.

Cypraea coxeni Cox, 1873, the only other species assigned by Schilder and others to this subgenus, lacks the distinctive dark apical spot. Cypraea dayritiana might also be considered to be closely related to C. coxeni, but it differs in the following respects: it is a smaller, more bulbously pyriform shell; it lacks the high, heavy marginal callus and a heavy brown dorsal coloring; it has a dull base and the black apex.

Key to the Species of *Cypraea* of the Subgenus *Blasicrura* s. s.

1. Adult shell with four black spots, two anteriorly and two posteriorly; base dull; labial and columellar teeth extending about halfway to the margins; tooth count (based on ten specimens): 17 to 21 (mean 19.2) labial; 17 to 21 (mean 18.6) columellar . . . . . . Cypraea quadrimaculata Gray, 1824

1a. Adult shell with at most two dark apical spots 2

2. Adult shell with more or less distinct transverse dorsal bands 3

2a. Adult shell never with transverse dorsal bands 4

3. Transverse dorsal bands obliquely interrupted; base glossy; labial and columellar teeth extending approximately halfway to the margins; tooth count (based on nine specimens): 18 to 24 (mean 22) labial; 16 to 22 (mean 18.8) columellar . . . . C. interrupta Gray, 1824

3a. Transverse dorsal bands perpendicularly interrupted; base glossy; labial and columellar teeth extending approximately halfway to the margins; tooth count (based on 18 specimens): 15 to 21 (mean 18.6) labial; 14 to 17 (mean 15.8) columellar . . . . .C. pallidula Gaskoin, 1848

4. Shell with mantle line; dorsum with faint light-brown spots; base glossy; teeth extend less than halfway to the margins; tooth count (based on six specimens): 16 to 18 (mean 17.5) labial; 15 to 18 (mean 17.2) columellar . . . . C. pallidula luchuana

4a. Shell without mantle line 5

5. Base of shell glossy; dorsum with numerous, relatively large, reddish-brown, confluent spots; labial and columellar teeth extending approximately halfway to the margins; tooth count (based on 12 speci-

Table 1

Specimen	Length (in millimeters)	Width	Height	Dentition lip	col.	Island where collected	Depth in feet	Collector	Collection
Holotype	15.1	10.0	8.0	14	14	Marily	6[1]	F. Dayrit	N. M. Philipp.
Paratype 1	19.5	12.8	10.2	16	17	Demang	5[2]	J. E. Norton	J. E. Norton
Paratype 2	15.1	9.7	13.0	15	13	Demang	5[2]	J. E. Norton	J. E. Norton
Paratype 3	20.0	12.8	9.8	17	15	Inlulucot	7[3]	J. E. Norton	J. E. Norton
Paratype 4	17.1	10.9	8.6	17	15	Inlulucot	12[3]	J. E. Norton	J. E. Norton
Paratype 5	17.4	11.1	9.0	14	14	Cagbatan	6[4]	Robert Lee	Robert Lee
Paratype 6	14.5	9.1	7.1	15	12	Demang	7[2]	Robert Lee	Robert Lee
Paratype 7	17.6	11.4	9.3	16	17	Cagbatan	6[1]	F. Dayrit	N. M. Philipp.
Paratype 8	15.8	10.0	8.2	15	16	Batunan	3[2, 5]	F. Dayrit	N. M. Philipp.
Paratype 9	15.5	10.3	8.2	15	13	Batunan	3[2, 6]	F. Dayrit	N. M. Philipp.
Paratype 10	15.1	9.3	7.8	15	13	Cagbatan	6[1, 6]	F. Dayrit	C. N. Cate

N. M. Philipp. = National Museum of the Philippines

[1] rocky, living corals, in rock crevices
[2] under and on top of rocks in shallow water
[3] rock and sand bottom
[4] found between dead seaweed and other sea plants
[5] subfossil
[6] dead specimen

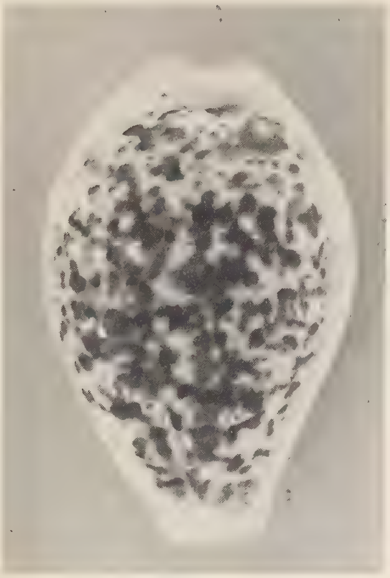

Figure 1

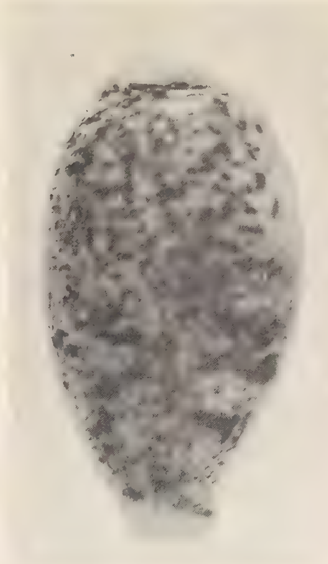

Figure 2

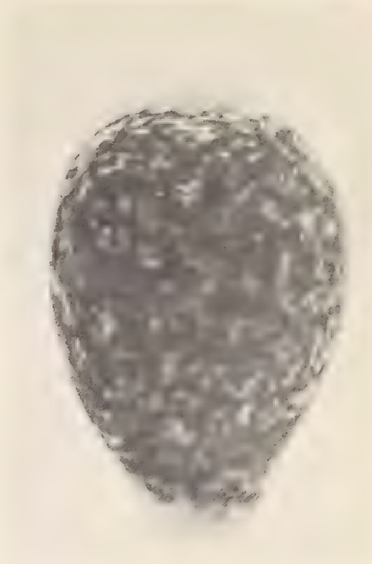

Figure 3

Figure 1 a

Figure 2 a

Figure 3 a

Dorsal and Ventral Aspects of
Cypraea dayritiana C. CATE, spec. nov., and *Cypraea pallidula luchuana* KURODA, 1960

Figure 1, 1 a: Holotype of *Cypraea dayritiana*
Figure 2, 2 a: Typical *Cypraea pallidula luchuana*
Figure 3, 3 a: Paratype No. 3 of *Cypraea dayritiana*

TAKEO SUSUKI, *photo*

mens): 14 to 17 (mean 15.9) labial; 16 to 19 (mean 16.8) columellar . . . . *C. coxeni* Cox, 1873

5a. Base dull; dorsum with numerous, fine, greenish-brown confluent spots; labial and columellar teeth extending to the margins; tooth count (based on 11 specimens): 14 to 17 (mean 15.3) labial; 12 to 17 (mean 14.5) columellar . . *C. dayritiana*, spec. nov.

Acknowledgment

I wish to thank Fernando Dayrit for the loan of specimens, for preparing a detailed map of the type locality area, and most of all for his many valuable contributions to our knowledge today of the marine molluscan fauna of the Philippine area. I further want to thank James Norton and Robert Lee for so willingly lending their specimens; my appreciation for their consideration of the problem also goes to Rose Burch and Ray Summers, the latter also having kindly loaned pertinent literature; and to Emily Reid for her excellent adaptation of Mr. Dayrit's map into a textfigure. To Jean Cate, as always, goes my gratitude for her interest and assistance, so necessary to the success of this work.

An Unusual Occurrence of *Tresus nuttalli* (Conrad, 1837) (Mollusca : Pelecypoda)

BY

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(3 Textfigures)

(Publication authorized by the Director, U. S. Geological Survey)

In the course of making collections of late Pleistocene invertebrates from the lowest emergent marine terrace along the central California coast, the pelecypod *Tresus nuttalli* (Conrad, 1837) (= *Schizothaerus nuttalli*) was found nestling in a boulder riddled with holes of boring mollusks. The fixed confines of this unusual ecologic niche resulted in a unique departure from the characteristic shell morphology of this species. *Tresus nuttalli* is ordinarily found burrowing deeply in sandy substrates. It is an abundant species in fossiliferous late Pleistocene terrace deposits in this area. For many years it has been commonly, although improperly (Keen, 1962), referred to the genus *Schizothaerus*.

The boulder was collected from a lens of fine-grained, micaceous, fossiliferous sand of late Pleistocene age. In this area several lenses of fossiliferous sand occur beneath large sandstone boulders and in depressions in the wave-cut platform. The locality is about 20 to 25 feet above sea level on a small point south of Cliff Drive approximately one-quarter mile west of Point Santa Cruz (near the $S\frac{1}{4}$ cor. $SW\frac{1}{4}$ of projected quad., 1954). The writer's interest was first drawn to this area by Bradley's report (1956) of a Carbon-14 date of more than 39,000 years on fossil shells collected from holes of rock-boring mollusks in the terrace platform west of the above described locality. Earlier collections from terrace deposits in the Santa Cruz area and to the northwest listed by Arnold (1908, pp. 355-356) included 32 species of mollusks, principally gastropods. Arnold's field notes indicate that the present locality is equivalent to his locality "near the light-house at Santa Cruz" (*ibid.*, p. 355).

The nestling specimen of Tresus nuttalli was found in a light grey, very fine grained, calcareous sandstone boulder measuring five inches in diameter. Borings in the well-rounded boulder are ovoid or egg-shaped with the broadly rounded, larger end toward the center of the rock (Fig. 1). Judging from the dimensions and size of the holes, the principal original boring organisms may have been Penitella penita (Conrad, 1837) or Zirfaea pilsbryi Lowe, 1931. Several specimens of these rock borers have been collected in situ by the writer from burrows in hard Miocene shale forming the low-lying Pleistocene wave-cut platform near Point Año Nuevo about 20 miles to the northwest. Varying degrees of exposure of original borings indicate

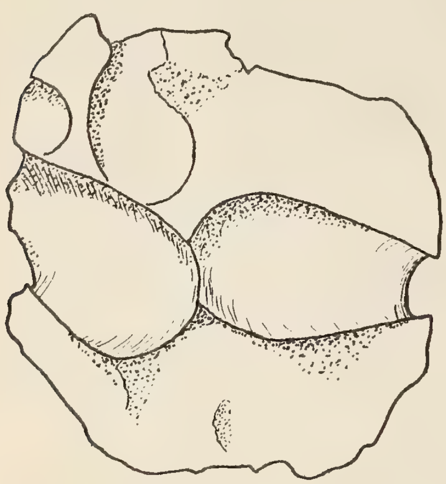

Figure 1: Interior of sandstone boulder (x 0.8) showing cavity, to the right, occupied by *Tresus nuttalli* (Conrad, 1837)

that the boulders resting on the terrace platform were greatly reduced in size by marine abrasion. In some cases only a trace of the anterior or innermost part of the original ovoid cavity remains. Pholads were not found in any of the boulders examined in this area. Rather, the cavities were occupied by paired valves of the nestling pelecypods Petricola carditoides (Conrad, 1837) and, in lesser numbers, Protothaca staminea var. ruderata (Deshayes, 1853). The gastropod Crepidula nummaria Gould, 1846, was also found nestling in borings in the boulders.

The unusual shape of the specimen of Tresus produced by confinement to the rock cavity is shown in Figures 2 and 3. Superficially, it

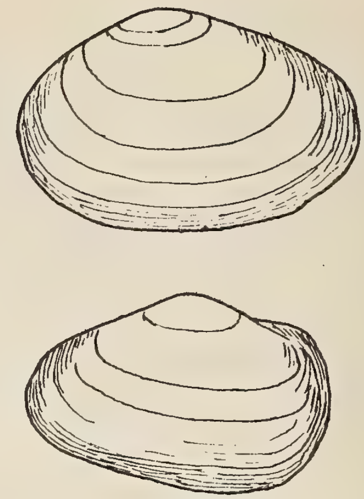

Figure 2: *Tresus nuttalli* (Conrad, 1837) External view of normal specimen (x 0.8, above) and nestling specimen (x 1.2, below), left valves

resembles the commonly occurring Petricola carditoides more closely than typical specimens of Tresus nuttalli occurring in the same deposit, yet the distinctive fine radial ribbing of the former permits ready external discrimination between the two species. Early concentric growth lines indicate a normal, subquadrate shape, yet the "adult" shell (0.8 in. high and 1.3 in. long) is ovoid in outline. At a critical stage in growth, the organism assumed an unusual position with the anterior end oriented toward the outer portion of the burrow. Although the posterior, siphonal end was directed toward the inner part

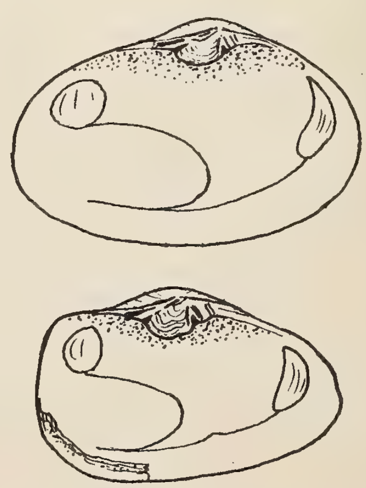

Figure 3: *Tresus nuttalli* (Conrad, 1837) Internal view of normal specimen (x 0.8, above) and nestling specimen (x 1.2, below), left valves

of the cavity, an ovoid burrow from the opposite side of the boulder intersected the hole in a manner which provided a small window through which the siphon could be extended (see Fig. 1). This enabled the clam to carry on normal filter-feeding activities although lodged "in the wrong direction" in the burrow.

This limiting ecologic niche so altered the shape of the shell that the position of the beak is medial rather than from one-third to one-fourth the distance from the anterior to the posterior end. The anterior end is pointed while the posterior end is broad and truncate, whereas in several normal specimens of Tresus nuttalli collected from the Santa Cruz locality, the posterior extremity is somewhat pointed while the anterior extremity is rather broadly rounded. The dentition and pallial markings on the inner surface of the valves, as well as the posterior gape for the siphons, compare favorably with normal specimens of this species.

Tresus nuttalli is usually found burrowing in sandy substrates, to considerable depths in the adult stage of development. The burrows are perpendicular to the surface. It is a common member of the burrowing fauna in sandy tidal flats near the mouth of Elkhorn Slough, 18 miles southeast of Santa Cruz, where it is actively sought by clam diggers. The species is found living, often in great abundance, in bay or estuarine and protected outer-coast environments. The bathymetric range is from the intertidal zone down to depths of 100 feet or greater (Fitch, 1953). The geographic range is from the Straits of Georgia, British Columbia (Quayle, 1960), to Scammons Lagoon, Lower California (Fitch, 1953).

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Notes on the California Species of *Aplysia* (Gastropoda : Opisthobranchia)

BY

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In preparation for the forthcoming key to the California opisthobranchs, it has been necessary to attempt to resolve some of the problems concerning the distribution and systematic status of the Aplysia of California. This information is published here to avoid bulk in the key's text. The subgenera given are those used by Eales (1960) in her revision of the world species of Aplysia.

1. Subgenus *Pruvotaplysia* ENGEL, 1936

Eales (1960) and Baba (1949) have indicated that California is included in the range of Aplysia parvula Guilding in Mörch, 1863. The only record of an actual collection from any point near to California seems to be that (as Tethys) of MacFarland (1924). He reported on three

somewhat macerated specimens from San Marcos Island, Gulf of California, Mexico. Therefore, A. parvula should not presently be considered as a California species.

2. Subgenus *Neaplysia* Cooper, 1863

Aplysia californica Cooper, 1863, is the most common sea hare in California. Aplysia nettiae Winkler, 1959, should be considered as a synonym of A. californica as the differences between the two are too small to be of specific importance. Its author, Dr. L. R. Winkler (Loma Linda University, written communication, January 1962), states that A. nettiae "may be the result of mutations with limited survival time". Eales (1960) also doubted the specific status of this form.

3. Subgenus *Varria* Eales, 1960

Although Eales (1960) reports Aplysia dactylomela Rang, 1828, as having worldwide distribution, there evidently have been no collection records for it from California.

The single known specimen of Aplysia rehderi Eales, 1960, is reported to be from Monterey, California (Eales, 1960). According to Dr. N. B. Eales (University of Reading, written communication, March 1962), the reference to A. rehderi as a Gulf of California species (Eales, 1960, p. 379) is a misprint. The locality label of this specimen (United States National Museum #575055) is open to question. J. H. McLean (Stanford University, written communication, July 1962) reports that this label's information was taken from the National Museum's old card filing system no. 1879 and did not include a date, collector, or more exact collection than just "Monterey". Dr. H. A. Rehder (United States National Museum, written communication, August 1962) confirms this, but he states that the 1879 may refer to the date of museum acquisition. My research work is now based at Monterey Bay, California, and I know of no species of Aplysia other than A. californica having been collected locally. In view of this confusion, A. rehderi cannot be seriously considered as a California species at present.

4. Subgenus *Aplysia* Linnaeus, 1767

Aplysia juliana Quoy & Gaimard, 1832, was listed by Eales (1960) as having been collected in California. She later stated (University of Reading, written communication, March 1962) that the record of A. juliana in California could not be traced and that such a record of A. "juliana is doubtful". J. R. Lance (Scripps Institution of Oceanography, written communication, February 1962) states that a similar note from Dr. Eales came too late to prevent A. juliana from being included in his southern California opisthobranch distribution list (Lance, 1961).

Aplysia vaccaria Winkler, 1955, is quite common in southern California.

Aplysia reticulopoda Beeman, 1960, is known only from southern California. This species should now be referred to the subgenus Aplysia rather than Tullia.

Aplysia cedrosensis Bartsch & Rehder, 1939, is known only from the Gulf of California and therefore is not a California species.

Aplysia cedrosensis and A. vaccaria seem more closely related to each other than either of them is to A. reticulopoda. The distinctions between A. vaccaria and A. reticulopoda have already been introduced (Beeman, 1960). Some comparisons of A. reticulopoda with A. cedrosensis and A. juliana are of interest. Although the latter two species are not California species, they are the only other members of this subgenus found in the north Pacific area. The following notes contrast A. reticulopoda with the information on A. cedrosensis and A. juliana given in Eales (1960) and Bartsch & Rehder (1939). It must be remembered that this represents study on only a few preserved specimens. Study must be made of large series of the fresh animals before really definitive and quantitative criteria can be established.

The proportions of Aplysia reticulopoda are quite different from those of A. cedrosensis and A. juliana; the head and neck appear as part of the body outline rather than as a projection from it. The skin is very smooth, not rough and warty. The cephalic tentacles are not well rolled and connected to the mouth as in A. juliana. The foot is proportionately wider and does not have lateral wings along the body or a suck-

er. The compound nature of the penial sheath warts contrasts with A. cedrosensis; their elaborate complexity may contrast with A. juliana. A glance at the illustrations of A. reticulopoda and A. cedrosensis (Beeman, 1960; Eales, 1960) shows that A. reticulopoda has a far more tightly closed parapodial enclosure. The short, simple, thick, tubular, anal siphon especially contrasts with the broad, nontubular siphon of A. cedrosensis. The number of lateral teeth (56) in the radula is much lower than A. cedrosensis (80) and much higher than A. juliana (40); the number of rows (119) is much greater than in A. juliana (70).

In summary: Only Aplysia californica, A. vaccaria, and A. reticulopoda can presently be considered as valid California species of the genus Aplysia. Distinctions within the subgenus Aplysia are considered.

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A Revised List of Chitons from Guadelupe Island, Mexico (Mollusca : Polyplacophora)

BY

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Emery P. Chace, Curator of Mollusks, San Diego Society of Natural History, included six species of chitons in a general list of marine mollusks from Guadelupe Island, Mexico. This list of chitons may now be augmented as a result of the collecting trip to the Island in 1946 by M. Woodbridge Williams, who brought back an interesting series of specimens, principally from tidepools. The chitons were mostly preserved in alcohol and deposited in the mollusk collection of the California Academy of Sciences.

In the following revised list, the records published by Chace (1958) are indicated as "C"; the records of Williams as "W". Numbers of specimens collected are shown in parentheses ( ).

LEPIDOPLEURIDAE

Leptochiton rugatus (Carpenter in Pilsbry, 1892) — C (1); W (1), a juvenile dredged in 26 fathoms off the south side of the Island, 9 December 1946 (CAS 32747), is tentatively referred to this species.

ISCHNOCHITONIDAE

Lepidozona asthenes Berry, 1919 — W (71), from a tidepool at the south end of the Island, 7 December 1946 (CAS 32746). Range extended southward from Palos Verdes Point, Los Angeles County, California (Thorpe). See remarks below.

Lepidozona? sp. — W (1) is a tiny juvenile from the same locality as the preceding. Too small to identify with any certainty.

Lepidozona mertensi (Middendorff, 1846) — C (2); W (21), from the same locality as the preceding. The specimens at hand, while somewhat smaller than the average run from central California, are otherwise typical of the species.

Stenoplax corrugata (Carpenter in Pilsbry, 1892) — C (1); W (2), from 26 fathoms off the south side of the Island, 9 December 1946 (CAS 32747). These are very young specimens that have the tail valve and the central areas of the intermediate valves rather heavily sculptured, as in S. corrugata, but identification must remain tentative until confirmed by the collection of adult specimens from the area. (Syn. S. biarcuata Dall, 1903, fide S. S. Berry).

Stenoplax heathiana Berry, 1946 — W (2), from a tidepool at the south end of the Island, 7 December 1946 (CAS 32746). While very young, these specimens have the relatively smoother sculpture of this species, to which they are provisionally referred.

Stenoplax? sp. — W (1), from a tidepool at the north end of the Island, 7 December 1946 (CAS 32819). Identification of this 2-millimeter example cannot be given with any certainty. It seems to differ from the other species of Stenoplax listed above.

Cyanoplax hartwegi (Carpenter, 1855) — W (6), from a tidepool at the south end of the Island, 7 December 1946 (CAS 32746). All specimens are quite small.

Lepidochitona sp. — C (1). Although I have not seen this specimen, I suspect it may be referable to L. keepiana Berry for faunistic reasons.

CALLISTOPLACIDAE

Callistochiton palmulatus mirabilis Pilsbry, 1892 — W (1), an adult specimen from the same locality as Cyanoplax hartwegi, preceding (CAS 32746).

Nuttallina fluxa (Carpenter, 1863) — C (3); W (8), from the same station as the preceding (CAS 32746), includes four adults and three juveniles. This was recorded by Chace as N. californica (Nuttall in Reeve, 1847), but this species is not certainly known to occur south of Point Conception, California.

MOPALIIDAE

Dendrochiton gothicus (Carpenter, 1863) — W (7), from a tidepool at the north end of the Island, 9 December 1946 (CAS 32819). This lot includes both adult and juvenile specimens, one of the latter curled around a small sea-urchin spine. Range extended southward from off southern California (San Pedro and Redondo).

Discussion

The collection made by Mr. Williams raises the number of chiton species in the Guadelupe Island fauna from six to at least ten and possibly more with confirmation of the identification of certain juvenile examples as the result of subsequent collecting. Ranges for two species are extended considerably southward.

The large series of Lepidozona asthenes Berry has been compared principally with specimens from the type lot in the author's collection (AGS Nos. 1700 and 1851) and also in the Academy's general collection (CAS 37998), together with three paratypes (CAS Geology Type Coll. Nos. 1127, 1128, and 1128a). Further comparison was also made possible by the discovery of a series of 18 specimens from the type locality collected in 1901 by Professor William J. Raymond under the auspices of the San Diego Marine Biological Association, which was included with other lots of chitons, mostly small, dredged off the coast of southern California. This series of specimens is now registered as AGS 10496 in the author's collection.

As might be suspected, there are a number of minor differences between lots from the two localities. The Guadelupe Island specimens run smaller, from less than 3.0 to about 6.0 mm in length, whereas those from White's Point range from 5.0 to 9.5 mm, all measurements being based on animals preserved dry. Color of the Guadelupe Island specimens is generally lighter, being mostly yellowish-white through cream to a light beige, although several have greenish flammulations. Their basic granular tegmental sculpture is somewhat finer and more cleanly outlined than on the specimens from White's Point. The small, occasional, easily abraded pustules are present on the lateral areas of some specimens from both localities. These

differences seem inconsequential and well within the possibilities of sculptural variation that might be expected in the species, especially in material from what could well be the northern and southern ends of its maximum geographical range. Nor will such an extension of range to the southward be any particular occasion for surprise for the reason that the chiton fauna of Guadelupe Island is composed largely, if not entirely, of species found living on the coast of southern California, as examination of the foregoing list shows. Incidentally, all lots of Lepidozona asthenes were collected intertidally, apparently in much the same type of habitat under small boulders and stones.

The specimens of Dendrochiton gothicus collected by Mr. Williams agree well with those dredged by John Q. Burch and others off San Pedro and Redondo, and in the region of San Diego. Finding this species intertidally seems unusual as existing records are generally from depths of 25 fathoms or more. Earlier collections of D. gothicus, taken from the backs of Haliotis, probably came from shallower water, but more recently it has been taken only by dredging.

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Cowrie Populations from Kenya
(Mollusca : Gastropoda)

BY

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The cowrie fauna of the Kenya coast is rather well known, especially by the papers of B. Verdcourt (1954-1962). For many years, Mr. R. S. Benton eagerly has collected cowries along this area, chiefly between Shimoni at the southern border of Kenya, and Shanzu some miles north of Mombasa (see below); from March 1961 to his leaving Kenya in June 1962, he has sent us 2,964 cowries from several localities, well preserved so that we could study the local variation of the shells as well as the relation of the characters of shells to the sex of the animal, and the variation of the radulae (see also Schilder, 1961c to 1963r).

LOCALITIES

The populations treated in the present paper have been collected at ten localities which are tabulated below. In this table, the six columns indicate the abbreviation (Ab.) used in this paper, name of the locality (Loc.), short description of the collecting field (Ecology), its general aspect towards the sea (Asp.), distance in kilometers and general direction from the central locality Mombasa Island (Dist.), and number of cowries sent to the writers (Cow.).

Ab.	Loc.	Ecology	Asp.	Dist.	Cow.
ShW ShE	Shimoni West Shimoni East	Corals on sandy and muddy bottom some mangroves	S S	75 S 75 S	246 559
Di	Diani	Small reefs in lagoon, bare reef	E	35 S	74
PR	Port Reitz	Tidal creek, sandy beach, dirty water	SE SW	8-5 W	711
Mo	Mombasa Island	Rocky cliffs, some caves	N, E	—	795
Ny	Nyali	Rather bare reef	SE	1 N	66
Sha	Shanzu	Reef, many loose rocks	E	7 N	210
Ki	Kikambala	Sandy beach, corals in lagoon, reef	E	15 N	157
Ta	Takaungu	Cliffs and bare reef	E	40 N	99
Mi	Mida Creek	Sand beach and bare reef	SE	70 N	47

Discussion

The reefs are uncovered at low to very low tides only; there are loose rocks and pools so that the conditions of food and shelter vary at short distances. The monsoon blows from the south from April to October, and from the north from November to March; in the former period the sea is rougher and considerably cooler. ShW (350 m long) and ShE (70 m) are separated by a zone (350 m only) where no cowries can live; both collecting fields are very similar except that in ShE there is a spit of sand between the field and the deep channel, whereas ShW gently slopes down to it; this deep channel, which is two km broad, separates ShW and ShE from Wasin Island in the south (see Schilder, 1962r). Di includes some few specimens from Likoni (farther north). PR includes the north coast of the basin as well as Flora Point in the south (see Schilder & Benton, 1962e). Ny includes English Point; this locality is separated from Mo by a narrow channel only. The cowries from Ki have been sent by A. J. Wiley in 1958, without animals; we doubt whether all specimens really have been collected on the reef of Kikambala in strict sense. All data concerning these localities kindly have been communicated to the writers by Mr. R. S. Benton, formerly living at Nairobi and Mombasa.

The environmental conditions of all reef localities facing the open sea from Di to Mi evidently are rather similar, though the aspect of the reefs constantly changes. ShW and ShE seem to differ by rather muddy bottom as they face the channel separating Wasin Island from the mainland; in this respect they seem to connect ecologically the reef localities with the only really aberrant collecting field PR, which lacks corals in its waters contaminated by harbour construction in the inland creek far off the open sea.

SPECIES

The following list contains all cowrie species reliably collected in southern Kenya between Shimoni and Kikambala; we have included rare species mentioned by Verdcourt from this region, but not found by Benton personally, and Zanzibar as indicated by Verdcourt, trying to arrange his various terms in five classes:

C = common
c = frequent
m = less frequent
r = rare
R = very rare

These abbreviations have been used also by Mr. Benton in a list summarizing the results of many years' collecting in Kenya, and we quote his classification of the relative frequency of each species at each locality; between the columns of ShW and ShE there is one common letter of frequency only, as Mr. Benton did not separate them first, and in Ta and Mi (outside the chief area investigated) there are no letters at all as he has collected there once only. We have added to these degrees of frequency estimated by Benton the number of specimens actually sent us by him as a result of 16 months' collecting. The last column contains the aver-

age frequency of each species in southern Kenya resulting from Benton's letters, often differing from the frequency in entire East Africa indicated by Verdcourt, and the number of specimens sent us by Mr. Benton and Mr. Wiley (from Ki only). The absence of any letter or figure indicates that no specimens have been collected nor sent, respectively.

The cowrie species have been arranged according to our catalogue of living and fossil Cypraeacea (Schilder, 1941v). The gaps separate the three subfamilies Cypraeinae, Nariinae, and Cypraeovulinae.

{Editor's Note: Because of our policy of never allowing a trivial name to stand alone, we have editorially added throughout Drs. Schilder's paper the genus names as used by them; we also added authors and years in most cases. This makes certain changes in the following statement obvious.}

We renounced, however, to add the generic names so that conchologists adopting the views of Dr. Kay (1960) may put the family genus Cypraea before each specific name mentioned in this paper, though we stick to the generic division of the cowries by historical and taxonomi-

Verdct.	ShW	ShE	Di	PR	Mo	Ny	Sha	Ki	Ta	Mi	Sum
Luria isabella (Linnaeus, 1758):											
C	25	c 40	c 10		c 51	c 4	c 32	c 9		3	c 174
Callistocypraea testudinaria (Linnaeus, 1758):											
R			R				R				R
Mauritia arabica immanis Schilder, 1938:											
c			r 1		m 11	m 13		r		1	r 26
Mauritia scurra (Gmelin, 1791):											
R			R				R 2				R 2
Mauritia histrio (Gmelin, 1791):											
C		r	m 3		c 14	m 4	c 10	m 11			m 42
Mauritia depressa (Gray, 1824):											
R			R								R
Mauritia mappa (Linnaeus, 1758):											
R							R				R
Mauritia mauritiana (Linnaeus, 1758):											
c					m 23	r					r 23
Talparia argus (Linnaeus, 1758):											
R			R								R
Talparia talpa (Linnaeus, 1758):											
m		r 1	r			r		r 1			R 2
Cypraea tigris Linnaeus, 1758:											
C	2	m 5	c		c 6	c 3	c	c 10			c 26
Cypraea lynx Linnaeus, 1758:											
c	7	C 126	c 1		c 47	c	c 27	c 10	6	1	c 225
Cypraea vitellus Linnaeus, 1758:											
c	9	m 32	c 2	r 1	c 14	m	c 2	c 10			m 70
Cypraea carneola Linnaeus, 1758:											
C	43	C 128	c 3		C 49	m 3	c 24	c 13			c 263
Cypraea titan Schilder, 1962:											
	74	47					19	7			m 147
Pustularia globulus (Linnaeus, 1758):											
R			R								R
Pustularia cicercula (Linnaeus, 1758):											
R			R								R
Monetaria annulus (Linnaeus, 1758):											
C	21	C	C		C173	C 20	C 1	C 10		35	C 260
Monetaria moneta (Linnaeus, 1758):											
C	1	m	m 9	C273	r	m 12	c 2	c 20	88		c 405

Verdct.	ShW	ShE	Di	PR	Mo	Ny	Sha	Ki	Ta	Mi	Sum
Erosaria gangranosa (Dillwyn, 1817):											
R			R					R			R
Erosaria helvola (Linnaeus, 1758):											
C	13	m 15	c 23	m 7	C215	m 2	c 48	c 10		3	c 336
Erosaria caputserpentis (Linnaeus, 1758):											
C			r		r		m 1	r 11	5		r 17
Erosaria poraria (Linnaeus, 1758):											
R							R				R
Erosaria erosa (Linnaeus, 1758):											
c	31	c 72	c 1	c 15	c 8	m 2	c 4	c 6		1	c 140
Erosaria marginalis (Dillwyn, 1827):											
R			R				R 1			R	R 1
Erosaria lamarckii (Gray, 1825):											
c				c 298							r 298
Staphylaea staphylaea (Linnaeus, 1758):											
m	2	m 12	m 1		m 8		m 3	m 2		1	m 29
Staphylaea limacina (Lamarck, 1810):											
c	2	m 12	m 1		m 8	r 1	m 15	m 2		1	m 42
Staphylaea nucleus (Linnaeus, 1758):											
r			r				R 2				R 2
Erronea onyx adusta (Lamarck, 1810):											
r				m 17							r 17
Erronea caurica (Linnaeus, 1758):											
C	3	m 2	c 1	c100	c 55	m	c	c 21			c 182
Palmadusta felina (Gmelin, 1791):											
m					r 2		r				R 2
Palmadusta punctata (Linnaeus, 1758):											
m		r 9	R 4				R 1				r 14
Palmadusta asellus (Linnaeus, 1758):											
m		R 1									R 1
Palmadusta clandestina (Linnaeus, 1767):											
r	1	r	m 1		m 8	m 2	m	m		1	m 13
Palmadusta ziczac (Linnaeus, 1758):											
R				R							R
Palmadusta diluculum (Reeve, 1845):											
c			r	r			r				R
Palmadusta fimbriata (Gmelin, 1791):											
m		r	m 8		c 64		m 6	r 1			m 79
Palmadusta microdon (Gray, 1828):											
R			R								R
Cribraria teres (Gmelin, 1791):											
m	6	m 17	m		m 28		m 3	m			m 54
Blasicrura kieneri (Hidalgo, 1906):											
C	1	m	m 2		m 7		m 5	m 3			m 18
Blasicrura owenii (Sowerby, 1837):											
R			R 1								R 1
Blasicrura stolida (Linnaeus, 1758):											
r	3	r 32									r 35
Cribraria chinensis (Gmelin, 1791):											
m	2	r 8	m 2		m 2		r 2	r			r 16
Cribraria cribraria (Linnaeus, 1758):											
m			r		r 2		r				r 2
SUM (45 species):	246	559	74	711	795	66	210	157	99	47	2964

cal, especially by paleontological and even by anatomical reasons, as the grouping of species published by Kay mostly confirms our systema; besides, if uniting all species to one genus only, several changes in specific names would be necessary by homonymy so long as one does not separate them generically once more. We shall discuss the matter in another paper.

Along the southern Kenya coast, Monetaria annulus evidently is the most common species; eight other species (Luria isabella, Cypraea tigris, C. lynx, C. carneola, C. moneta, Erosaria helvola, E. erosa, Erronea caurica) are also frequent, while nine species (Mauritia histrio, C. vitellus, C. titan, Staphylaea staphylaea, S. limacina, Palmadusta clandestina, P. fimbriata, Cribraria teres, Blasicrura kieneri) are less frequent; the remaining 27 species are rare to very rare.

The populations inhabiting the fringing reefs along the southern Kenya coast (Di, Mo, Ny, Sha, Ki) are rather similar with regard to the frequency of species, though there are some local peculiarities: Cypraea carneola, Erosaria helvola, and Palmadusta fimbriata evidently are more frequent in Mo than elsewhere, whereas C. titan is absent.

The populations living at Shimoni on the northern shore of the Wasin Channel evidently differ by the absence of the solid species Mauritia arabica, M. histrio, M. mauritiana, and Erosaria caputserpentis, which are replaced by the only occurrence of Blasicrura stolida and by increased frequency of Cypraea lynx, C. carneola, and C. titan with less calloused margins; besides, Monetaria moneta, E. helvola, and Palmadusta fimbriata seem to be less frequent at Shimoni than at the localities along the open sea. The predominancy of C. titan over C. carneola in ShW, contrary to that of C. carneola over its sibling ally at ShE, has been discussed by Schilder (1962r).

The population living in the harbour of Port Reitz is quite different: both groups of species enumerated above as absent and as abundant at Shimoni are totally absent in PR, as is Luria isabella and the species most common elsewhere, Monetaria annulus; they are replaced by an increased number of M. moneta and evidently also of Erronea caurica, and by two species collected in no other place in southern Kenya by Benton: Erosaria lamarckii and the less frequent Erronea onyx.

In southern Kenya Erosaria erosa seems to be the only species occurring at all localities in rather similar percentage.

SEX

Among 2,179 adult cowrie specimens with well preserved animals, 1,179 females have been stated by absence of a penis; these 54±1.1 percent of females significantly differ from the theoretically expected 50 percent, so that the females evidently predominate a little ($P<0.001$).

Nevertheless, in several species the percentage of females much differs from the average 54 percent, especially in Erosaria lamarckii (36±4.5), Luria isabella (47±4.2), and Palmadusta fimbriata (69±6.0), but only the first named difference is significant ($P<0.001$): this scarceness of females in 115 E. lamarckii (with animals) from Port Reitz cannot be caused by local conditions, as in 260 Monetaria moneta from the same locality the females are significantly predominant (60 ± 3.04 percent, $P<0.001$).

If we comprise several allied species, or similar localities, we detect interesting differences, as follows.

animals	group	females (percent)
833	Cypraeinae (Luria isabella; Cypraea titan)	50 ± 1.7
1048	Nariinae (Monetaria annulus; Staphylaea limacina)	55 ± 1.5
298	Cypraeovulinae (Erronea onyx; Cribraria chinensis)	61 ± 2.8
1221	From channel localities (ShW, ShE, PR)	52 ± 1.4
958	From reef localities facing the open sea	57 ± 1.6

Therefore, in Cypraeinae the females are relatively less frequent than in Cypraeaovulinae (the difference is significant: $P<0.001$), the Nariinae are intermediate. In the three channel localities the females are evidently less frequent than in the seaside reefs, though this difference is much less significant ($P<0.05$, but >0.02). It seems difficult to explain all these facts.

VARIATION

Various sets of any species collected in different times at the same locality never differ significantly each from the other in any character of the shell nor of the radula: slight differences between the means never exceed the limits of random generally admitted in statistics. In a former paper (Schilder, 1962m), we have published the variation of several characters of shell, animal, and radula in Monetaria moneta, from PR, collected 27 August 1961; the means of these 180 shells (92 radulae) do not differ significantly, in any character discussed, from a second set containing 80 shells (72 radulae) collected at PR 25 October 1961; the characters of 73 and 25 Erronea caurica collected there the same days are practically identical, too. The means of various characters of 30, 31, and 29 Cypraea carneola (C. titan excluded) collected at ShE 28 August 1961, 23 November 1961, and 5 April 1962, respectively, also agree within the admitted limits.

On the other hand, populations coming from different localities often differ in various characters in a significant way.

The most striking character of cowrie shells is their size. The following table indicates the mean of length (in mm) of several populations (20 to 260 shells); they have been arranged according to the lengths of shells and connected by the signs: o, *, and **, which indicate increasing significance of $P>0.01$, $P<0.01$, and $P<0.001$, respectively (see Schilder, 1962r, 1963r; the means have been calculated in tenths of mm).

The fact that Mo is mostly represented on the left border of this list and ShE on its right border apparently points to some general influence of the ecological conditions to the relative size in many or even in all species.

Such a local parallelism may be illustrated by expressing each local mean in percent of the average length of the species in the western Indian Ocean (the Red Sea and South Africa excluded), i. e., in the tropical coast of East Africa (Benton's Kenya localities excluded) and in the adjacent islands from Madagascar to Chagos Archipelago. We prefer, however, to express the figures in parts of 20 instead of in parts of 100, so that the difference 1 is equal to 5 percent. The following table shows on its left column the length of rather frequent species in the Indian Ocean (in mm); the following columns indicate the differences of the local means from this general size equal to index 20. The right column and the lowest line contain the means of each species in the whole area of Kenya investigated by Benton, and the general influence of each locality on all cowries, respectively. Local series of less than four specimens of a species have been omitted in this table, but proportionally considered when we have calculated the horizontal and vertical means.

The total mean 19.7 shows that the cowries from Benton's collecting fields generally are about 1.5 percent smaller than those living abroad in the western Indian Ocean. Some species, however, as Blasicrura stolida, Palmadusta fimbriata, and Mauritius arabica immanis distinctly exceed the usual means, while Staphylaea limacina and P. clandestina are smaller than in other regions. The mean size of all cowries is rather similar in most localities of Kenya, except in Mo, where most species are unusually small, and in ShE where all species tend to gigantism (the mean 20.4 in the adjacent ShW, however, far less exceeds the usual size).

The other measurable characters of the shells can be treated in an analogous way: the relative breadth (expressed in percent of length)

Luria isabella	Mo	24	o	Sha	25	o	ShW	26	**	ShE	30	(Mo ** ShW; Sha ** ShE)
Cypraea lynx	Mo	31	**	Sha	36	**	ShE	39				
Cypraea carneola	Mo	24	**	Sha	27	**	ShW	29	**	ShE	31	
Cypraea titan	Sha	45	o	ShW	47	**	ShE	54				
Monetaria annulus	ShW	20	o	Mo	20	*	Mi	22				
Monetaria moneta	Ta	21	**	Ki	23	o	PR	24				
Erosaria helvola	Mo	18	**	Sha	20							
Erosaria erosa	ShW	33	o	ShE	33							
Erronea caurica	Mo	31	**	PR	34							

	mm	ShW	ShE	Di	PR	Mo	Ny	Sha	Ki	Ta	Mi	Mean
Luria isabella	27	20	22	19		17	(20)	18	20			19
Mauritia arabica immanis	72					21	23					22
Mauritia histrio	57					21	(23)	19	19			21
Mauritia mauritiana	79					21						(21)
Cypraea tigris	85		21			19			17			19
Cypraea lynx	35	21	22			18		21	20	20		20
Cypraea vitellus	41	20	24			17			20			20
Cypraea carneola	29	20	22			17		19	22			20
Cypraea titan	49	19	22					19	18			19
Monetaria annulus	21	19				19	20		20		21	20
Monetaria moneta	21			19	23		17		22	20		20
Erosaria helvola	20	23	23	21	18	18		21	22			21
Erosaria caputerpentis	32								17	18		18
Erosaria erosa	32	20	21		18	19		(23)	21			21
Erosaria lamarckii	39				16							(16)
Staphylaea staphylaea	17		22			16						19
Staphylaea limacina	24		20			14		14				16
Erronea onyx	43				19							(19)
Erronea caurica	37				18	17			20			19
Palmadusta punctata	15		23	(16)								20
Palmadusta clandestina	17					16						17
Palmadusta fimbriata	12			25		20		21				22
Cribraria teres	30	22	23			17						20
Blasicrura kieneri	18					19		18				18
Blasicrura stolida	25		24									(24)
Cribraria chinensis	32		22									20
Mean		20	22	20	19	18	20	19	20	19	20	19.7

and the closeness of teeth (Schilder, 1958z). If compared with specimens from other regions of the western Indian Ocean as limited above (the mean figures have been adopted from Schilder, 1952d), Mauritia mauritiana, Cypraea tigris, and Erosaria caputserpentis are broader in the Kenya populations (index 21), while C. titan and Cribraria chinensis are more slender (19). In C. teres and C. chinensis (more than in Erronea onyx and Palmadusta punctata) the teeth of both lips are unusually close (index 22 to 23), while in Blasicrura kieneri the labial teeth exceed only, and in Staphylaea limacina the columellar ones only; in M. arabica and Cypraea tigris the labial teeth are too close and the columellar teeth are too distant (index 21: 18); whereas in P. fimbriata (and M. histrio) the labial teeth are unusually distant (18), and in M. mauritiana the teeth of both lips are rather scarce (index 19:19). Generally, in the Kenya populations the teeth of both lips are relatively more close in the species belonging to the progressive subfamilies Nariinae and Cypraeovulinae (index 21) than in the more primitive Cypraeinae (index 20).

The next table illustrates the general tendency of all cowrie species in each locality of Kenya. The figures indicate classes of 5 percent as explained above (20 is equal to 100 percent); they refer to four characters of the shell (L = length, BL = relative breadth, LT and CT = closeness of labial and columellar teeth, respectively), as well as to three characters of the radula ribbon (dr/L) (see Schilder, 1963r). On the contrary to the characters of the shell, the percentage of those of the radula refers to the sum of Kenya localities, as the radula of most species from the Indian Ocean outside Kenya is unknown.

Loc.	L	BL	LT	CT	r/12	m/L	dr/L
ShW	20	19	21	21	20	19	19
ShE	22	20	21	21	20	19	19
Di	20	20	20	20	20	21	21
PR	19	21	20	21	20	19	18
Mo	18	20	20	20	20	20	20
Ny	20	20	20	20	20	21	20
Sha	19	20	20	20	20	21	21
Ki	20	20	21	20	—	—	—
Ta	19	21	21	20	(20)	(22)	(22)
Mi	20	20	20	20	20	19	20
Mean	19.7	20.1	20.4	20.3	20.0	20.2	20.1

One will observe that, besides the increased size of all species in ShE and the reduced size in Mo discussed above, the shells from PR (and Ta) are broad, those from ShW are slender. In both collecting fields at Shimoni (ShW and ShE) the teeth are more numerous on both lips: this parallelism points to the reality of the difference probably caused by environmental conditions, whereas the scattered figures 21 in three other localities may be accidental only. There is no difference in the number of radula rows among the Kenya populations; according to the columns m/L and dr/L, however, the radulae of reef localities (especially in Di, Sha, and Ta) show a distinct tendency to become relatively large (broad and long), whereas in all channel localities (ShW, ShE, and PR) they are evidently too small (narrow and short) if compared with the size of the shells; the dependence of the relative size of the radula upon local conditions probably concerning food is striking.

The distribution of other varieties in structure and color is rather equal in the populations from southern Kenya, though there are several local differences in percentage of varieties indicating some influences of habitat. So, for instance, in Monetaria annulus the ecotype A (Schilder, 1932d, p. 99) predominates in all populations, with tendencies towards Q in Mi and Ny, and towards H in ShW. In Monetaria moneta the ecotype R predominates, tending towards S (margins sharply expanded) in Ki and towards C (margins roundly swollen) in PR (Schilder, 1962m, p. 100); in M. moneta the presence of an orange ring decreases from Di> Ta> Ki> Ny> PR, whereas the "golden" suffusion increases from Di= Ta= Ny > Ki >PR, showing some inverse correlation. In Erosaria helvola the predominance of the white specks (Schilder, 1952d, p. 79) decreases from Di >Ki= Sha >Mo=ShE >ShW, where the brown spots predominate. In E. erosa the marginal swelling increases from ShW<ShE< Mo<Sha<PR, indicating a surprising parallelism to the development of the lateral blotches from ShW < ShE < Mo < Sha < PR, where even the labial blotch is never absent. In Erronea caurica the dorsal blotch generally is less developed in PR, if compared with Ki and Mo. Extreme individual varieties, as Cypraea vitellus with richly vinous base, E. erosa with well developed basal lines (recalling C. nebrites), etc., as well as several species dorsally suffused with greenish enamel, sporadically occur in many localities, but no rostrate specimens have been observed among the 3,000 shells from Kenya.

Summary

The statistical analysis of cowrie populations coming from ten localities in southern Kenya show a pretty large uniformity among the seaside reef localities, whereas the populations coming from the Wasin Channel and from the inland creek Port Reitz distinctly differ both in selection of species and in predominance of certain varieties of shell and radula.

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NOTES & NEWS

The Terebridae (Mollusca : Gastropoda) of Bileau Island, Madang Harbour, New Guinea

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Through the courtesy of Mrs. Isobel Pert, I have recently had the opportunity to examine and study a large number of Terebridae specimens collected by her at Bileau Island, Madang Harbour, Territory of New Guinea (rounded to nearest degree as 6° 0' S. Lat.; 146° 0' E. Long.).

The collecting area consists of a reef approximately 40 to 60 yards in width extending offshore on the east and southeast sides of the island. This reef, about one-half mile in length, has a maximum tide variation of two and one-half feet. Due to the limited areas of sand and silt-filled pockets on this reef, no dredging has been attempted; all specimens have been collected with the aid of a glass-bottom bucket after raking of the bottom deposits. A deep ship channel drops abruptly from the seaward side of the reef, and this, along with the prevalence of sharks, had made collecting impractical in waters deeper than three feet.

It is of interest to observe that Mrs. Pert's collecting has resulted primarily in large quantities of minute and small juvenile specimens; large adult specimens have seldom been taken in this immediate area. The island is enhanced as a habitat for juveniles by a seaward island which keeps the water in a relatively calm condition and by a large silted crater resulting from World War II.

Mrs. Pert's residence on Bileau Island during 1961-1962 has made year-round collecting possible at this location with the present specimens, all live-taken, having been collected during this time. Of additional interest is Mrs. Pert's observation that Terebridae can always be found on the island at a location where the natives habitually discard edible refuse, meat tins, etc.

The following species have been obtained as a result of Mrs. Pert's intensive and competent collecting at Bileau Island during 1961-1962:

Terebra (Decorihastula) affinis Gray, 1844 (non Turton, 1932)
- T. striata Quoy & Gaimard, 1832 (non Gray, 1844; non Basterot, 1825)
- T. eburnea Hinds, 1844 (non Philippi, 1846; non Dunker, 1825)
- T. pertusa Kiener, 1838 (non Bron, 1780; non Sowerby, 1897)

Terebra (Subula) areolata (Link, 1806) (non Adams & Reeve, 1850)
- T. muscaria Lamarck, 1822

Terebra (Subula) argus Hinds, 1844
- T. nebulosa Kiener, 1860 (non Sowerby, 1825; non Lorois, 1858)

Terebra (Dimidacus) babylonia Lamarck, 1822
T. striata Gray, 1844 (non Quoy & Gaimard, 1832; non Basterot, 1825)

Terebra (Strioterebrum) cancellata Quoy & Gaimard, 1832
T. undatella Deshayes, 1859

Hastula (Hastulina) casta (Hinds, 1844)
T. albula Menke, 1853
T. bipartita Deshayes, 1859
T. incolor Deshayes, 1859
T. medipacifica Pilsbry, 1920
T. medipacifica melior Pilsbry, 1920
T. natalensis E. A. Smith, 1901

Terebra (Abretiella) cerithina Lamarck, 1822
T. pulchra Hinds, 1844

Terebra (Dimidacus) cingulifera Lamarck, 1822
T. puncticulata Sowerby, 1825
T. punctatostriata Gray, 1844
T. pallida Deshayes, 1857
T. crenifera Deshayes, 1859
T. columnaris Deshayes, 1857
T. chinensis Deshayes, 1857

Terebra (Decorihastula) columellaris Hinds, 1844
T. areolata Adams & Reeve, 1850 (non Link, 1806)
T. propinqua Pease, 1869

Terebra (Oxymeris) crenulata (Linnaeus, 1758)
T. fimbriata Deshayes, 1857
T. interlineata Deshayes, 1859
T. booleyi Melvill & Standen, 1898
T. varicosum (Gmelin, 1791)

Terebra (Subula) dimidiata (Linnaeus, 1758)
T. splendens Deshayes, 1857

Terebra (Oxymeris) felina (Dillwyn, 1817)
T. tigrina (Gmelin, 1791; p. 2602; non p. 3475)
T. suffusa Pease, 1869

Terebra (Dimidacus) funiculata Hinds, 1844
T. archimedis Deshayes, 1859

Terebra (Terebra) guttata (Röding, 1798)
T. oculata Lamarck, 1822
T. sculptilis Pease, 1869
T. ornatum (Martyn, 1786)
T. nebulosa Lorois, 1858 (non Sowerby, 1825; non Kiener, 1860
T. loroisi Deshayes, 1859

Hastula (Impages) hectica (Linnaeus, 1758)
T. caerulescens Lamarck, 1822
T. flammulata Martens, 1881

Terebra (Dimidacus) laevigata Gray, 1834

Terebra (Acuminia) lanceata (Linnaeus, 1758)

Hastula (Hastula) lauta (Pease, 1869)

Terebra (Oxymeris) maculata (Linnaeus, 1758)

Terebra (Decorihastula) marmorata Deshayes, 1859
T. amoena Deshayes, 1859

Terebra (Decorihastula) nebulosa Sowerby, 1825 (non Lorois, 1858; non Kiener, 1860)

Terebra (Punctoterebra) nitida Hinds, 1844
T. plicatella Deshayes, 1857

Terebra (Acuminia) penicillata Hinds, 1844

Terebra (Decorihastula) pertusa (Born, 1780) (non Kiener, 1838; non Sowerby, 1897)
T. bermonti Lorois, 1858

Terebra (? Diplomeriza) raphanula Lamarck, 1822

Terebra (Strioterebrum) roseata Adams & Reeve, 1848

Hastula (Hastulina) solida (Deshayes, 1857)

Terebra (Terebra) subulata (Linnaeus, 1758)

Terebra (Decorihastula) undulata Gray, 1834
T. pertusa Kiener, 1838 (non Sowerby, 1897; non Born, 1780)
T. approximata Deshayes, 1857

Hastula (Hastula) verreauxi (Deshayes, 1857)
T. strigilata (Linnaeus, 1758) (Description is too vague)
T. striatula Kiener, 1838 (non Lamarck, 1822)
T. acumen Deshayes, 1857
T. argenvillei Deshayes, 1859
T. matheroniana Deshayes, 1859
T. modesta Deshayes, 1859
T. concinna Deshayes, 1857 (non Dillwyn, 1817)

Terebra (Decorihastula) sp.

Terebra (Punctoterebra) sp.

Terebra (?Oxymeris) sp. (cf. T. buccinulum Deshayes, 1857)

Acknowledgment

The kindness and generosity of Mrs. Pert in having made these specimens available for study is acknowledged with gratitude. With her permission, duplicate specimens of the above species have been placed with institutions and students in several countries as well as in my own collection.

Range Extensions for *Terebra robusta* Hinds, 1844 and for *Terebra formosa* Deshayes, 1857

BY

HELEN DUSHANE

Conchological Club of Southern California
Los Angeles 7, California

In April 1962, two specimens of Terebra robusta Hinds, 1844, were taken at Puertecitos, Baja California. One, a beach specimen, measures 88 mm in height and 15 mm in greatest diameter, while the one taken alive measures 78 mm and 15 mm, respectively. These two specimens were reported in DuShane (1962). In December 1962, a third specimen was taken, the second living one known from this locality; it measures 100 mm in height and 20 mm in greatest diameter. Keen (1958) reports the range from Guaymas, Mexico, to Ecuador and the Galapagos Islands. The finding of these specimens extends the known range northwest from Guaymas 300 miles. Moreover, it is the first record of T. robusta from the east coast of Baja California.

In April 1960, during a low night tide, a Terebra was collected as a beach specimen, different from any other species from this genus taken at Puertecitos. Tentatively identified by Dr. Bruce Campbell later in 1960 as T. formosa Deshayes, 1857 (type locality: Panama), the specimen meets all the requirements of T. formosa as shown in Campbell (1963). In this article he reports an extension of range from Panama to Mazatlán, Mexico, approximately 2,000 miles northwest. The record of the specimen from Puertecitos extends the range about 650 miles northwest from Mazatlán, placing it on the eastern coast of Baja California peninsula, or 2,650 miles northwest of Panama.

Literature Cited

Campbell, Bruce
1963. Rediscovery of Terebra formosa Deshayes, 1857. The Veliger 5 (3): 101–103; plts. 12, 13.

DuShane, Helen
1962. A checklist of mollusks for Puertecitos, Baja California, Mexico. The Veliger 5 (1): 39–50; 1 map.

Keen, A. Myra
1958. Sea shells of tropical west America; marine mollusks from Lower California to Colombia. Stanford Univ. Press, xi + 624 pp.; illus. Stanford, Calif.

Notes on a *Mitrella* (Mollusca : Gastropoda) from the Gulf of California

BY

FAYE B. HOWARD

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Santa Barbara Museum of Natural History

Recently, while reviewing several species of the genus Mitrella Risso, 1826, from the Gulf of California and West Mexico, I took a more careful look at what I had been calling M. ocellata (Gmelin, 1791). This is a common species in the Lower Florida Keys, the West Indies, and Bermuda (Warmke & Abbott, 1961). In "Sea Shells of Tropical West America" Dr. Myra Keen (1958) places Columbella guttata Sowerby, 1832, in synonymy with M. ocellata. However, she does so with the comment that the Sowerby name is available if a difference can be detected.

Examination of long series of the brown, white-spotted Mitrella that I have collected on both sides of the northern end of the Gulf of California showed in every specimen a much lighter band around the bodywhorl just below the periphery. In "Caribbean Seashells" by Warmke & Abbott, the illustration of Nitidella ocellata (Gmelin) shows no sign of the lighter band; the text states ". . . color dark-brown with white spots."

During November 1962, at the California Academy of Sciences, I examined a large lot of Mitrella ocellata from Key West, Florida. Once again I found no sign of the distinctive, light colored band of the Gulf of California form. At the same time I saw several specimens of M. o. baileyi Bartsch & Rehder, 1939, from the Galapagos Islands. These shells seemed more robust than the Gulf form and, more importantly, did not show the light band below the periphery.

Later, I discussed these observations with Dr. Keen, and she concurred with my opinion that there was, in fact, a definite difference between the Caribbean and the Gulf of California forms.

With this in mind, I now propose that Mitrella guttata (Sowerby, 1832) shall be used for the Gulf of California banded form of this complex. I further believe that M. ocellata baileyi shows a closer affinity with the Caribbean form and should be retained as it stands at present. These two — M. o. ocellata and M. o. baileyi — seem to be another instance of the analogous species so frequently found separated by the land bridge between North and South America.

Acknowledgment

I wish to thank Dr. Leo G. Hertlein and Allyn G. Smith of the California Academy of Sciences for making material available for comparison; and to express my appreciation to Dr. A. Myra Keen of Stanford University for the time she spent discussing the problem with me. Last but not least, I wish to thank my private pilot — my husband, Lewis W. Howard — for transportation during this research.

Literature Cited

Keen, A. Myra
1958. Sea shells of tropical west America; marine mollusks from Lower California to Colombia. Stanford, Calif., Stanford Univ. Press; xi + 624 pp.; illust.

Warmke, Germaine L., & R. Tucker Abbott
1961. Caribbean seashells; a guide to the marine mollusks of Puerto Rico and other West Indian islands, Bermuda and the lower Florida Keys. Narberth, Penna.; Livingston Publ. x + 346 pp; 44 plts.; 19 maps; 34 textfigs.

Two Range Extensions

BY

ALLYN G. SMITH

Associate Curator, Department of Invertebrate Zoology
California Academy of Sciences, San Francisco 18, California

PECTEN CAURINUS GOULD —

The range of this species is stated by Hertlein (1940, p. 69) to extend from Channel Island, Orca Inlet, Cordova, Alaska, to off Point Reyes in central California. The California Academy of Sciences has just received two perfect pairs collected in April 1955 by the United States Fish and Wildlife Service off Sand Point, Shumagin Islands, in the Aleutians. They are large examples, measuring in length and height 190 by 175 mm and 175 by 164 mm, respectively. This new locality extends the range of the species approximately 580 miles to the west. These shells have been deposited in the Academy collection by Karl W. Kenyon, Biologist of the Fish and Wildlife Service, and are accessioned by the Department of Geology as No. 38381.

LEPETA CAECOIDES CARPENTER —

Specimens referred to this species were taken recently by the Trawler "Warrior" (Captain Davies) at two locations: in 85 to 130 fathoms, off the Big Sur, Monterey County, California, on a large mammalian femur (C. A. S. Geol. Dept. No. 38534); and in 100 fathoms off Davenport, Santa Cruz County, California (C. A. S. Geol. Dept. No. 38531). Although Dall (1921, p.

168) gives the southern end of the range of this species as the Farallons, San Francisco County, California, Keen (1937, p. 37) shows the southern end to be Latitude 37°, which is in the neighborhood of Santa Cruz, California. The Big Sur locality extends this another one-half degree to the south.

Literature Cited

HERTLEIN, LEO GEORGE
1940. Addition to the range of *Pecten caurinus* GOULD. The Nautilus 54 (2): 68-69.

KEEN, A. MYRA
1937. An abridged check list and bibliography of west North American mollusca. Stanford Univ. Press, Stanford, Calif. pp. 1-88.

Sixteenth Annual Meeting American Malacological Union Pacific Division

The 1963 meeting of the American Malacological Union, Pacific Division, will convene at 1:30 p.m. on Wednesday, June 26, 1963, on the beautiful seaside campus of the University of California at Santa Barbara. Registration will take place from 9:00 a.m. to noon of that day.

In addition to the many formal papers and informal discussions that are always so well received, a few highlights of the meeting will include: an informal reception on the first evening, hosted by members of the new Santa Barbara Malacological Society; a visit to the University's marine laboratory, whose tanks will be specially stocked for our enjoyment with living local marine organisms; a banquet in the beautiful Cloud Room at the new shorefront Santa Barbara Inn; special exhibits of interest to all collectors, on view in the lobby of the dormitory — and many other attractions.

Those staying on campus will be housed in Santa Rosa Hall, one of the new, well-equipped large dormitories. With the exception of the banquet, meals will be available at De la Guerra Commons. Formal programs will be presented in one of the classroom auditoriums within walking distance of the dormitory.

The costs of attending the conference are as follows: Single accommodation, \$24.00; double, \$19.50 each. This cost includes room with maid service for the period from Wednesday noon through Saturday noon, June 26 to 29; registration fee; and banquet. All other meals will be on an a la carte basis, reasonably priced with an anticipated average of from \$2.00 to \$4.00 per person per day, according to his appetite.

To assure best selection of rooms, please send in your reservations, with a \$10.00 deposit, at your earliest convenience. For information address Mrs. Ruth French, Secretary, 2335 West Lomita Boulevard, Lomita, California.

Books, Periodicals & Pamphlets

THE FAUNA AND ECOLOGY OF GASTROPOD MOLLUSKS (Gastropoda, Prosobranchia) OF THE LITTORAL OF THE KURILE ISLANDS

by A. N. Golikov and O. G. Kussakin
Department of Hydrobiology
Leningrad State University

Investigations of the Far Eastern Seas of the USSR, Issue VIII, 1962, Academy of Sciences of the USSR, Zoological Institute, pp. 248-346, pls. 1-2 (photographic), text figs. 1-13. Moscow/Leningrad. (In Russian with no English abstract.)

This appears to be an important contribution to the ecology of mollusks, with particular emphasis on the life histories of a considerable number of far northern littoral species. For a number of them, illustrations of egg cases are included. It is to be hoped that an English translation of this paper will be available soon.

AGS

MARINE MOLLUSCAN GENERA OF WESTERN NORTH AMERICA

by A. Myra Keen

profusely illustrated, 126 pages
Stanford University Press, Stanford, California.
$ 4.50

Dr. Keen's keys to the pelecypod and gastropod genera of western North America have long been in constant use and filled a great need of professional and amateur students of the shells of the Pacific Northwest. These two keys have gone through many editions. But with the publication of the present handsome book Dr. Keen has not only included three of the groups formerly omitted (Scaphopoda, Cephalopoda and Amphineura) but she has also reworked the former keys to make them even more comprehensive and easier to use. In addition all the figures for the pelecypod key have been redrawn or are replaced with entirely new ones.

Innovations in this book include a tabulation of all molluscan genera recognized in the keys in alphabetical order with an indication of the approximate number of species included in each, the distribution and some ecological information. The glossary of special terms and the short bibliography will also be welcomed by all users of this new book.

We do not like to use the expression: this is a must in the library of every serious shell collector. But we do not see how we can avoid it in this instance. We also find it superfluous to mention that the book shows the usual excellence which characterizes all of Dr. Keen's work.

RS

THE UNDERWATER NATURALIST

Vol. 1, No. 1. November 1962.

This is the official journal of the American Littoral Society, a national organization of amateur and professional naturalists "devoted to the conservation and underwater study of animals and plants in the littoral (shore) area of the sea". The society was founded in April 1961 under the guidance of the U. S. Fish and Wildlife Service's Sandy Hook Marine Laboratory. A group has just been organized in California.

This first issue of the publication deals primarily with fish, although the society is interested as well in mollusks and other marine invertebrates. Dues of the society are $3.00 annually ($5.00 for family membership). The address is:

American Littoral Society
Box 117 Highlands, New Jersey

AGS

NEW SPECIES OF GASTROPODS OF THE GENUS NEPTUNEA BOLTEN FROM THE FAR EASTERN SEAS OF THE USSR

by A. N. Golikov
Zoological Institute,
Academy of Sciences, Leningrad, B-164

Transactions of the Zoological Institute of the Academy of Sciences of the USSR, vol. 30, 1962, pp. 1-10, 3 maps in text, 3 plates (unnumbered) with figs. 1-13. Moscow/Leningrad. (In Russian with no English abstract.)

Describes three new species and one new subspecies of Neptunea. The photographic illustrations are excellent.

AGS

LABORATORY GUIDE AND NOTES FOR MEDICAL MALACOLOGY

by Emile A. Malek

Burgess Publishing Company, Minneapolis 15, Minnesota. Pp. 154; 55 text-figures and plates. 1963. $5.50.

This book is intended, as the title implies,

as a guide for laboratory work with mollusks which play an important role in medicine; thus, it deals with those forms which serve as intermediate hosts in the life cycle of important parasites of man, as well as with the more generally known venomous forms such as the cones and octopuses. It is profusely illustrated with diagrammatic line drawings of dissections of the important forms, as well as with photographs of all species treated. Keys are provided for land snails and slugs, and extensive tables contain well organized information. A very useful feature of the book is the bibliography covering 19 pages.

While the book is primarily intended for the student of MEDICAL malacology, the introductory chapters covering the anatomy and morphology of mollusks in general will prove of interest also to the general student of malacology.

RS

WEST AMERICAN MOLLUSKS OF THE GENUS *CONUS* — II

by G Dallas Hanna

Calif. Acad. Sci., Occasional Paper No. 35, pp. 1-101, figs. 1-4 in text, pls. 1-11 (in color). January 28, 1963.

This is the long-awaited revision of an earlier monographic work by this author and the late A. M. Strong (Proc. Calif. Acad. Sci., 4th Ser., vol. 26, no. 9, January 28, 1949), which has been unavailable for a number of years. While much of the text of the 1949 work is repeated, the present monograph is by no means a reprint as much new and authoritative information is included that has become available since 1949. One new species, *Conus emersoni*, from 300 fathoms off Cabo San Lucas, Baja California, is added to the previous list.

This review of the West American cone-shells is especially notable for its exquisite color plates, which were reproduced in the Academy's shop by Dr. and Mrs. Hanna with the assistance of Academy photographic experts C. E. Crompton and Maurice Giles. Original Kodachrome transparencies were taken by Dr. Hanna using electronic flash equipment. By this means and the use of an extremely fine engraver's screen (266 dots to the inch), it has been possible, after much experimentation, to obtain faithful color reproduction showing the fine detail so necessary in good scientific illustrations. So far as known, this is the first scientific work of any scope with illustrations based upon the Eastman Short-Run Three-Color Process and run off on an ordinary small multilith press, employing aluminum masters instead of the far more expensive copper engravings.

A total of 34 species and subspecies of West American cone-shells is discussed in the monograph. An excellent key, plus the color plates, should make identification a relatively simple matter. All pertinent information on each species is covered, including taxonomy, type locality and location of the type specimen, range and collecting stt
BPP continuation

ity and location of the type specimen, range and
collecting stations, color and sculptural variability, ecological data if known, etc. There is a good index of scientific names.

While the author is the first to point out that his work is probably not the last word on West American cone-shells ever to be said, there is no doubt that his contribution is a useful and valuable one, which certainly will be considered by students and specialists in the Family Conidae as the "last word" for a long time on the colorful and variable West American representatives of this family.

AGS

INTRODUCTION TO SEASHORE LIFE
of the San Francisco Bay Region and the Coast of Northern California

by Joel W. Hedgpeth

University of California Press, 1962. Pp. 136; 8 color plates and 80 line drawings. $1.95.

Although the title of this little jewel by Joel would indicate a fairly restricted scope, the book contains more basic invertebrate zoology than many twice its size and four times its

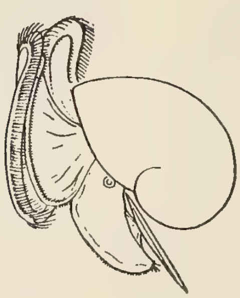
price. Not only has the author reviewed the fundamentals of this subject in a direct and readable manner, he has thrown in an excellent summary of important oceanographic processes and a bit of modern ecological energetics as well.

Most of the book is devoted to descriptions and illustrations of the more common littoral animals with comments on their life history and behavior (when known). There seem to be few errors in the text; however, I doubt that many algologists consider diatoms to be a "phylum"; octopuses are not "quite harmless" in that some people have been reported to react rather strongly to bites from these beasts. There is also some confusion with scientific names: Modiolus demissus appears in the text, while a neighboring figure is labeled Volsella demissa; Archidoris montereyensis and Anisodoris nobilis do resemble one another closely, but that is no reason to combine their names on page 105.

The illustrations are, for the most part, very good and deserve a better job of printing. Many, such as the upwelling diagram, should have had more space. The colored plates are excellent, and those of the starfish are close to being real works of art. The diagrams of the basic structure of the major invertebrate phyla will, I hope, be copied on hundreds of Junior and State College blackboards all over the West.

Perhaps in a future edition the author will explain the significance of some of the outstanding landmarks he has indicated on his map of the area, particularly 929 Chestnut Street.

John A. McGowan



THE VELIGER is open to original papers pertaining to any problem concerned with mollusks.

This is meant to make facilities available for publication of original articles from a wide field of endeavor. Papers dealing with anatomical, cytological, distributional, ecological, histological, morphological, physiological, taxonomic, etc., aspects of marine, freshwater or terrestrial mollusks from any region, will be considered. Even topics only indirectly concerned with mollusks may be acceptable. In the unlikely event that space considerations make limitations necessary, papers dealing with mollusks from the Pacific region will be given priority. However, in this case the term "Pacific region" is to be most liberally interpreted.

It is the editorial policy to preserve the individualistic writing style of the author; therefore any editorial changes in a manuscript will be submitted to the author for his approval, before going to press.

Short articles containing descriptions of new species or lesser taxa will be given preferential treatment in the speed of publication provided that arrangements have been made by the author for depositing the holotype with a recognized public Museum. Museum numbers of the type specimens must be included in the manuscript. Type localities must be defined as accurately as possible, with geographical longitudes and latitudes added.

Short original papers, not exceeding 500 words, will be published in the column "NOTES & NEWS"; in this column will also appear notices of meetings of the American Malacological Union, as well as news items which are deemed of interest to our subscribers in general. Articles on "METHODS & TECHNIQUES" will be considered for publication in another column, provided that the information is complete and techniques and methods are capable of duplication by anyone carefully following the description given. Such articles should be mainly original and deal with collecting, preparing, maintaining, studying, photographing, etc., of mollusks or other invertebrates. A third column, entitled "INFORMATION DESK," will contain articles dealing with any problem pertaining to collecting, identifying, etc., in short, problems encountered by our readers. In contrast to other contributions, articles in this column do not necessarily contain new and original materials. Questions to the editor, which can be answered in this column, are invited. The column "BOOKS, PERIODICALS, PAMPHLETS" will attempt to bring reviews of new publications to the attention of our readers. Also, new timely articles may be listed by title only, if this is deemed expedient.

Manuscripts should be typed in final form on a high grade white paper, 8½″ by 11″, double spaced and accompanied by a carbon copy.

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